MDC G4287

NOVEMBER 1972



PERFORMANCE ANALYSIS AND DESIGN SYNTHESIS (PADS) COMPUTER PROGRAM

VOLUME II Program Description Part 2 Final Report

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

MCDONNELL DOUGL

COPPORATION

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BY GUIDANCE AND FLIGHT MECHANICS DEPARTMENT
RESEARCH AND DEVELOPMENT
MCDONNELL DOUGLAS ASTRONAUTICS COMPANY-WEST
HUNTINGTON BEACH, CALIFORNIA
FOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY-WEST

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Quasi-Linearization Trajectory Module (GRØPE)

INTRODUCTION

This section of Volume II is devoted to the QL module of PADS. Execution of this module is initiated when and if subroutine PADSI calls subroutine GROPE. Subroutine GROPE controls the high level logical flow of the QL module.

The purpose of the module is to determine a trajectory that satisfies the necessary variational conditions for optimal performance. As is shown in Section 16 of Volume I, the QL module achieves this end by solving a non-linear multi-point boundary value problem. The numerical method employed, which is alternately known as quasi-linearization or the generalized Newton-Raphson operator, is described in Section 17 of Volume I. It is an iterative technique that converges quadratically when it does converge.

The module consists of three basic steps: (1) initialization, (2) iteration, and (3) culmination. The second step has two distinct components: (A) integration of the particular and homogeneous solutions, and (B) satisfaction of the boundary conditions. Both of these components are executed for each iteration in step 2.

The FORTRAN names of the primary entry points to these steps are:

Step 1 CHECK
Step 2A SALVE
Step 2B COHOMO
Step 3 WRAPUP

The flow chart of subroutine GROPE on the next page depicts the sequence in which these steps are executed. The listing of GROPE following the flow chart is a CDC-compatible version. As a result, the transfers to the above

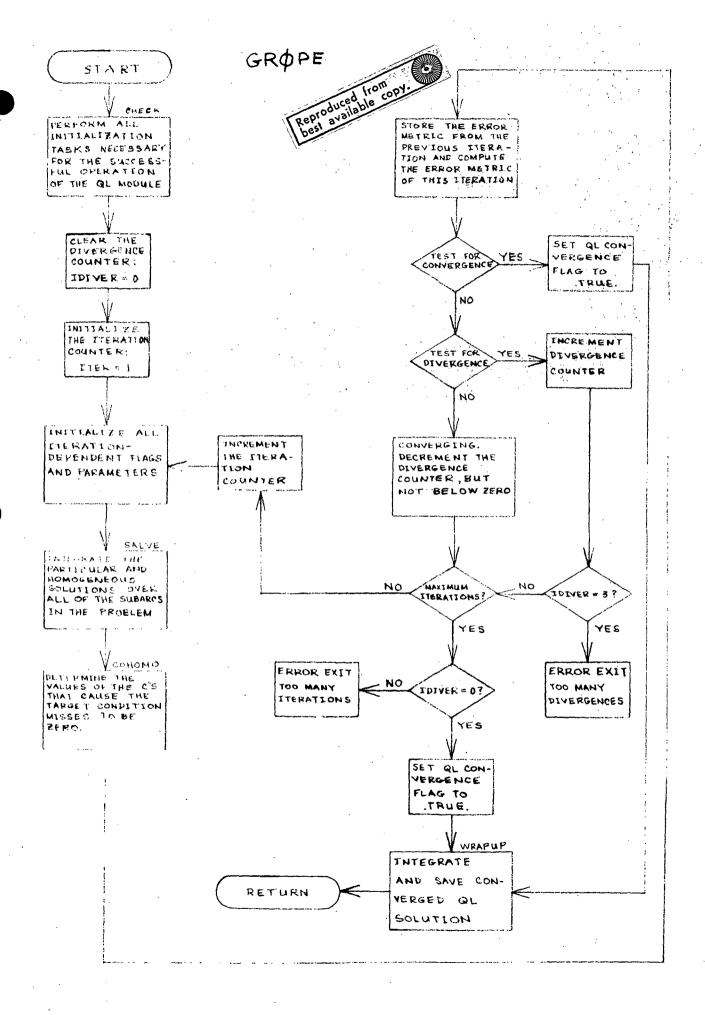
entry points appear as calls to OVERLAY. The correspondence of entry points to OVERLAY calls is:

CHECK CALL OVERLAY (6HH75021, 4, 1, 6HRECALL)

SALVE CALL OVERLAY (6HH75022, 4, 2, 6HRECALL)

COHOMO CALL OVERLAY (6HH75023, 4, 3, 6HRECALL)

WRAPUP CALL OVERLAY (6HH75024, 4, 4, 6HRECALL)



```
PROGRAM GROPE
                                                                                                                                                                                                      GROPE
GROPE
   2.3.4.56.789.
                                                                THIS ROUTINE CONTROLS THE OVERALL FLOW OF THE QL MODULE OF PAGS
                                                                                                                                                                                                      GROPE
GROPE
                         GROPE
                                                                                                                                                                                                     GROPE
GROPE
CNTRL
CNTRL
CNTRL
CNTRL
CNTRL
 ıó.
 11.
12.
13.
14.
15.
16.
                                                                                                                                                                                                      Ď
                                                                                                                                                                                                      JUL21
                                                                                                                                                                                                      PC
PC
Z
ZD
                                                                                                                                                                                                     GLOBAL
GLOBAL
GLOBAL
GLOBAL
GLOBAL
                                                                                                                                                                                                      BLOCK
                                                                                                                                                                                                     BLOCK
BLOCK
GROPE
GROPE
33.
34.
35.
36.
37.
38.
39.
                                                                                                                                                                                                     GROPE
GROPE
GROPE
            C
                                                                                                                                                                                                     GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
                         SET POINTERS TO SCRATCH FILES. ITAPA HAS THE PARTICULAR AND HOROGENEOUS SOLUTIONS FROM THE LAST ITERATION. ITAPA WILL CONTAIN THE SAME INFO. FROM THIS ITERATION.

IF(MOD(ITER, 2) NE. 1) GO TO 101

ITAPA = 12

ITAPA = 4

GO TO 102

ITAPA = "
411...
423...
445...
447...
449...
450...
                                                                                                                                                                                                      GROPE
                                                                                                                                                                                                     GROPE
GROPE
GROPE
GROPE
                                                                                                                                                                                                      GROPE
GROPE
                                                                                                                                                                                                                          162
                  101 ITAPA = 4
ITAPB = 12
53.
                                                                                                                                                                                                     GROPE
                                                                                                                                                                                                     GROPE
                 102 REWIND 4

REWIND 12

DD 103 I =

103 Y(I) = 0.

MOM = 0
                                                                                                                                                                                                     GROPE
GROPE
55.
557.
557.
558.
662.
667.
667.
                                                                                                                                                                                                    GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
                                                  = 1, MUP
            ç
                                                               SET KODES TO ZERO SO THAT NLDRY WILL ZERO OUT JACOB
                            KODES = 0
                           KODES = 0

INTEGRATE PARTICULAR AND HOMOGENEOS SOLUTIONS OVER
ALL THE SUBARCS.

CALL OVERLAY(6HH75022, 4, 2, 6HRECALL)
DETERMINE THE VALUES OF THE C+S THAT CAUSE THE
TARGET CONDITION MISSES TO BE ZERO.

CALL OVERLAY(6HH75023, 4, 3, 6HRECALL)
STORE EAROR METRIC FROM LAST ITERATION
            C
                                                                                                                                                                                                    GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
            C
                           COMPUTE ERROR METRIC FOR THIS ITERATION

RHOC = MAG(C, NOKNOW)

PRINT ERROR METRIC

WRITE(6, 1) RHOC
```

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```
1 FORMAT(1HO, 13MERROR METRIC=, E14.7)

ARE ME CONVERGED

1F(RHOC - EPSLOM) 108, 109

YES. SET QL CONVERGENCE FLAG
  75.
76.
77.
78.
                                                                                                                                                                               GROPE
GROPE
GROPE
GROPE
  79.
80.
81.
                  108 KONVER = .TRUE.
60 TO 112
                                                                                                                                                                               GROPE
GROPE
GROPE
                                                         DID WE DIVERGE
                  109 IF(RHOC .LT. RHOP) GO TO 110
YES. INCREMENT DIVERGENCE FLAG
IDIVER = IDIVER + 1
HAVE WE ACCUMULATED 3 DIVERGENCES
IF(IDIVER .EQ. 3) CALL ERROR(GROPEK, -5, 0)
                                                                                                                                                                             GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
  82.
83.
84.
85.
86.
87.
88.
                          IFCIDIVER
60 TO 111
                                                         CONVERGING.
                                                                                    BECREMENT DIVERGENCE FLAG
  89.
                  110 IDIVER = MAXO(O, IDIVER - 1)
                                                                                                                                                                              GROPE
 90.
91.
92.
93.
94.
95.
                                                                                                                                                                             GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
GROPE
                  111 CONTINUE
                          RUN OUT OF ITERATIONS. SHALL WE CALL IT CONVERGED ANYWAY

1F(IDIVER .EQ. 0) GO TO 1111

NO. LET STEEP. DESC. GENERATE A BETTER STARTING SOLUTION IF IT WANTS TO.:

CALL ERROR(GROPEX, -3, 0)
 97.
98.
99.
            1111 KONVER = .TRUE.

CONVERGED. SAVE CONVERGED SOLUTION AND PRINT 1T
C OUT IN ALL ITS GLORY.
                                                                                                                                                                             GROPE
GROPE
GROPE
100.
101.
102.
                 112 CALL OVERLAY(6MH75024,4, 4, 6MRECALL)
RETURN
END
                                                                                                                                                                             GROPE
GROPE
GROPE
```

ORTRAN- Symbol	MATH Symbol	CODE	DESCRIPTION	BLOC	OPAGE K	LOC	SUBROU SUBR		E USAGE
c	c	1	A forty mord array containing the vector of c's, i.e. the multipliers for the homogeneous solutions.	/0	· /(11)	BNDRY BRANPT GROPE INTRPT NEMCS NLBRY NOMNAL WRAPUP	1 # 1	BCB00000
EPSLON	€	1	OL iteration convergence criterion.	/GLOBA	L/(8)	CHECK GROPE	Ħ	EPSLON EPSLON
ITAPA -		0.	Number of the logical unit containing the quasitime histories of the particular and homogeneous solutions from the preceding QL iteration.	/CNTRL	. 11	3 }	GROPE NOMNAL	0	ITAPA ITAPA
ITAPB	<i>:</i>	.0~	· · · · · · · · · · · · · · · · · · ·	/CNTRL	. /Č	4)	GADPE Salve	0	ITAPB ITAPB
ITER		M	OL iteration number.	/CHTRL	/(2)	ETIME GROPE OUTPUT	M.	ITER ITER ITER
ITRMAX		1	Maximum number of QL iterations.	/GLOBA	L/(10)	CHECK GROPE	M	ITRMAX ITRMAX
KODES		. 0	Not used.	/CNTRL	/(56)	GROPE NLDRY Wrapup	0 # 0	KODES KODES KODES
KONVER		0.	Logical flag that indicates to the OL module that the OL iteration is converged.	/CNTRL		28)	#LGCON APPLY ARCIM COHOMO GROPE NLDRY OUTPUT RKUTT1	I 0 0 1 I	KONVER KONVER KONVER KONVER KONVER KONVER KONVER
PAGE		. 0	Not used.	/CNTRL	70	21)	CHECK GROPE	0	KPAGE KPAGE
10 M		0	The number of homogeneous solutions currently being integrated.	/CNTRL	/(GROPE INARC LIMDRY NOMNAL SALVE WRAPUP	Ħ	MOM MOM MOM MOM MOM
NO K NO W		1	The total number of free (unknown) state and costate variables over all the subarcs:	/BLOCK	/(•	CHECK COHOMO COSTAB COSTAI COSTAO GROPE MAGIC	Ħ	NO KNO W NO KNO W NO KNO W NO KNO W NO KNO W NO KNO W
IUP '		ſ	Same as MU.	/CNTRL	/(2,3)	CHECK GROPE INARC	0 1 1	NUP NUP NUP
C HDC		D M	Not used	/PC	/(SROPE CHECK	0.	PC -
HOP		••	The magnitude of the error in the current OL iteration. The magnitude of the error in the proceeding OL	/CNTRL		-	CHECK GROPE CHECK	0 M 0	RHOC RHOC RHOP
			The magnitude of the error in the preceding QL iteration.	/CNTRL			GROPE	A	RHOP
			An 820 word array containing the particular and homogeneous solutions being integrated. The first 18 words comprise the particular solution. Each block of 18 words thereafter comprises an independent homogeneous solution.	/¥			INARC MADAMS QLTOSZ RKUTT1 SALVE		A A A A A A

6 OCT 72 6.01-44

BLØCK ARCDAT

FORTRAN Symbol	MATH Symbol	DESCRIPTION		BLOCK	LOC	SUBROUT SUBR C	NE USAG
	· · · · · · · · · · · · · · · · · · ·		······································		 -		
SREF	Sref	Aerodynamic reference area	(FT ²)	/ARCDAT/C	1)	BNDRY	ARCDA
*		•				WRAPUP .	
E7	Aexit	Nozzie exit area	(FT ²)	/ARCDAT/(2)	ARCIN	EJ
XISP	Isp	Vacuum specific impulse	(SEC)	/ARCDAT/(3)	ARCIN IMPULS	
TMULT	Toult	Thrust multiplier or number of engines		/ARCDAT/(4)	ARCIN STATEF	TAULT
DTWC	Δ7	Integration interval	(SEC)	/ARCDAT/(5)	MRAPUP .	BTMC
DTPI		Print frequency for trajectory		/ARCDAT/(6)	WR AP UP	DTPI
IATR		Atmosphere option flag		/ARCDAT/(7)	ARCIN NLDRV OUTPUT STATEF	NTAL
1 400		Control mode option flag		/ARCDAT/(8)	ARCIN CONTRL NPLANE	IMODE
JAER		Aerodynamic model aption fing		/ARCDAT/(9)	AEROCO ARCIN DUTPUT STATEF	JAER JAER JAER
•						UT,	
JPRO		Propulsion model option flag		/ARCDAT/(10)	ARCIN :	
ZAND	PMAX	Maximum dynamic pressure instantaneous inequ limit	ality (PSF)	/ARCDAT/(.11)		
GMAX	G _{MAX}	Maximum total acceleration g load		/ARCDAT/(12)	ALS NPLANE THROTL TH3	GMAX GMAX
XLAMX	LMAX	Maximum serodynamic lift	(LBS)	/ARCDAT/(13)	NPLANE :	• • • • • • • • • • • • • • • • • • • •
HDMAX	Q _{MAX}	- Maximum heating rate inequality constraint	•	/ARCDAT/(14)		
GMDOT	7*	Pitch rate	(DEG/SEC)	/ARCDAT/(15)	ARCIN	6MDGT
ALFMAX	^œ max	Meximum angle of attack	(0E6)	/ARCDAT/(16)	ARCIN I	
PHMAX		Belly down flag		/ARCDAT/(CONTRL :	PHMAX
MAEA		Curve number		/ARCDAT/(18)	ARCIN STATEF	
MAEB		Curve number .		/ARCDAT/(19)	STATEF 1	MAED
MAEC		Curve number		/ARCDAT/(20)	STATEF 1	MAEC
1AED	•	Curve number		/ARCDAT/(21)	STATEF 1	MAED
1AEE		Curve number		/ARCDAT/(22)	STATEF !	MAEE
MEF		Curve number		/ARCDAT/(23)	STATEF 1	MAEF
MAEG		Curve number	•	/ARCDAT/(24)	STATEF I	MAEG
4T		Curve number -thrust table		/ARCDAT/(251	ARCIN :	AT
NI SP		Curve number kISP loss table		/ARCDAT/(ARCIN I	MISP
MAXCG		Curve number -xcg table		/ARCDAT/(271	STATEF 1	
MZ CG		Curve number- zcq table	•	/ARCDAT/(STATEF 1	
_	G. 01-47				201		

ORTRAN Symbol	MATH Symbol	DESCRIPTION	STORA(LOC	SUBROU SUBR		
MWDB		Description not input	/ARCDAT/(30)	ARCIN		MUDB
MD8		Curve number - base drag table	/ARCDAT/(• • •	ARCIN STATEF	I	MD8 MD8
XCGR	X _{CGR}	Reference mcg location (FT)	/ARCDAT/(32)	UT	I	XCGR
ZCGR	Z _{CGR}	Reference zcg location (FT)	/ARCDAT/(33)	UT	1	ZCGR
XE	X _E	Engine thrust centroid body x station	/ARCDAT/(34)	DL2	I	XE
2 E	ZE	Engine thrust centroid body z station	/ARCDAT/(35)	DL2 UT		ZE ZE
X T	x _T	Aerodynamic trim surface body x station	/ARCDAT/(36)	UT	1	XT
DREF	D _{ref}	Aerodynamic reference length	/ARCDAT/(37)	STATEF		DREF DREF
RHOB	Pb	Atmosphere base density for heating calculation (LB/FT++3)	/ARCDAT/(39)	NLDR V PDBCQL		RHOB RHOB
OMULT .	=0 0R 1	Heating flag multiplier	/ARCBAT/(40)	NLDRY POBCOL		OMUL!
REMAX	R	Maximum unit reynolds number inequality constraint	/ARCDAT/(41)			
FRATE.	-/881	Input rated vacuum thrust per engine (LBS)	/ARCDAT/(42)	ARCIN	m	FRATE

BLØCK AXLE

FORTRAN Symbol	MATH Symbol.	DESCRIPTION	5 T 8 L D C	K	LOC	SUBRO	COD	E USA

١٧	a¥	The first word of a four word array that contains the vector of applied accelerations defined by Equation 2.4-2 in Vol.I of this document.	/AXLE	/(1)	APPLY APPLY NLDRY	M 0 1	AV AXLE
6		Description not input	/AXLE	/(2)	APPLY	M I	AG AG
P		Description not imput	/AXLE	/(3)	APPLY	Ħ	AP
M	·	Description not input	/AXLE	11	4)	NLDRV APPLY	1	AP AM
144	3a ^v /3v	The first entry in a 4x8 matrix that contains the total partial derivatives of the a vector mith respect to the GL state vector (excluding the heating state), $\partial a/\partial y$.	/AXLE	/(5)	NLDRY NLDRY	I M I	WAA WAA
RA		Description not input	/AXLE	/(6)	APPLY NLDRY	0 I	AGV
NP V		Description net imput	/AXLE	/(1)	APPLY	0	APV
MV		Description not imput	/AXLE	/(8)	APPLY	0	AMV
		Description not imput	/AXLE	/(9)	NLDRY NLDRY	1	AWV
66		Description not input	/AXLE	/(10)	APPLY WLDRY	M 1	AGG
PG		Description not imput	/AXLE	/(11)	APPLY NLDRV	M	AP6
MG .		Description not input	/AXLE	/(12)	NLDRY	1	AMG
VP		Description not imput	/AXLE	/(13)	NLDRY	1.	AVP
MP		Description not imput	/AXLE	/(16)	NLDRY	1	AMP
VR -	•	Description met imput	/AXLE	/(17)	APPLY NLDRV	0 I	AVR AVR
GR		Description not input	/AXLE	*(18)	APPLY NLDRY	o I	AGR AGR
PR	•	Description not imput	/AXLE	` /(19)	APPLY NLDRY	0	APR
MR		Description not imput	/AXLE	/(20)	APPLY	0	AMR
٧n		Description not imput	/AXLE	,,,	21)	NLDRV	i	AVO
MO		Description not input	/AXLE	70		MLDRY	i	AFEG
VM		Description not imput	/AXLE	10		APPLY NLDRY	0	AVA
64		Description not imput	/AXLE	/(30)	APPLY NLDRY	0 1	AGR
PM		Description not input	/AXLE	/(31)	APPLY	0	APM
MM .		Description not input	/AXLE	/(12)	NLDRY	I I	APM
VZ		Description not input	/AXLE	70		NLDRY	ī	AVZ
6Z		Description not input	/AXLE	70		NLDRY	i	AGZ
P 1		Description not imput	/AXLE	n		NLDRY	1	APZ
MZ		Description not input	/AXLE	/(NLDRY	I	AMZ
AVV	δ a */δ v	The first entry in a 4x8 matrix that contains, when a is optimal, $\delta a/\delta y = \partial a/\partial y \Big _{\alpha} = constant$	/AXLE	/(37)	APPLY NLDRY	I	EAVV
		When a is nonoptimal, $\delta a/\delta y = \partial a/\partial y$						
AGV		Description not input		/(NLDRY	ı	EAGV
APV		Description not input	/AXLE	/(NLDRY	1	EAPV
AMV AVR		Description not input	/AXLE	/(NLDRV	I	EAMV
NOV 72		Description not imput	AXLE	/(49).	NLDRV	I	EAVE

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					•
FORTRAN	MATH		DECEDIDATION	STORAG	E SUBROUTINE USAGE
SYMBOL	SYMBOL		DESCRIPTION	BLOCK	LOC SUBR CODE VAR
EAGR		Description not	laget	/AXLE /(50) NLDRY I EAGR
EAPR		Description not		/AXLE /(51) NLDRY I EAPR
EARR		Description not	input	/AXLE /(52) NLDRY I EAMR
EAVM		Description not	Input	/AXLE /(61) NLDRY I EAVR
EAGR		Description not	· · · · · · · · · · · · · · · · · · ·	/AXLE /(62) NLDRY I EAGN
EAPM		Description not	•	/AXLE /(63) NLDRV I EAPM 64) NLDRV I EAMM
EAVZ		Description not Description not		/AXLE /(64) NLDRV I EAMM 65) NLDRV I EAVZ
EAGZ		Description not	•	/AXLE /(66) NLDRV I EAGZ
EAPZ		Description not	Input	/AXLE /(67) NLDRY I EAPZ
EAMZ		Description not	input	/AXLE /(68) NLDRY I EAMZ
AVVV	γ(δ ₈ ^γ /δγ)/3γ	The first entry a(5a/5y3/aV.	in a 4x8 matrix that contains	/AXLE /(69) APPLY O AVVV APPLY I AVV NLDRV I AVVV
AGVV		Description not	input	AXLE /	70) APPLY O AGVY
APVV		Description not	Input	/AXLE /(71) APPLY O APVV NLDRV I APVV
AMVV		Description not	Input	/AXLE /(72) APPLY D AMVV
AVRV		Description not	Input	AXLE /	81) APPLY M AVRV
AGRV		Description not	input .	/AXLE /C	82) APPLY M AGRY
APRV	,	Description not	Input	/AXLE /(83) APPLY M APRV NLDRV I APRV
AMRV		Description not	input	/AXLE /(84) APPLY O AMRV NLDRV I AMRV
AVRV		Description not	Input	/AXLE /(93) APPLY M AVMV
AGAV		Description not	Input	/AXLE /(94) APPLY M AGMY NLDRY I AGMY
APRV	•	Description not	Input	/AXLE /(95) APPLY M APMY NLDRY I APMY
VMMV		Description not	input	/AXLE /(96) NLDRY I AMMY
AVZV		Description not	•	/AXLE /(91) NLDRY I AVIA
AGZV		Description not		/AXLE /(98) NLDRY I AGZY
APZV		Description not	•	/AXLE /(99) NLDRY I APZY
AVVG	9(8a ^v /8V)/8v		in a 4x8 matrix that contains	/AXLE /(101) NLDRY I AMZY
AGVG		∂(δa/δy)/∂γ Description not	Input	/AXLE /C	102) APPLY O AGYG
AP VG		Description not	input	/AXLE /(NLDRY I AGYG
AMVG		Description not	innut	/AXLE /(NLDRV I APVG
AVG6		Description not	•	/AXLE /(105) NLDRY I AVGG
AMGG		Description not	•	/AXLE /(108) NLDRY I AMGG
AVRG		Description not	Input	/AXLE /(113) NLDRY I AVRG
AGRG		Description not	input	/AXLE /(114) APPLY D AGRG
APRG		Description not	Input	/AXLE /(115) APPLY O APRG NLORV I APRG
AMRG		Description not	Input	/AXLE /(116) NLDRY I AMRG
AVMG		Description not	•	/AXLE /(125) NLDRY I AVAG
10 NOV 72	2 6.01-47	•			•

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			LOC	SUBR	LUVE	VAR
					_	
NGMG	Description not input	/AXLE	/(126)	APPLY NLDRV	0	AGMG AGMG
PRE	Description not input	/AXLE	/(127)	APPLY	0 I	APMS APMS
MMG	Description not imput	/AXLE	/(128)	NLDRV	1	AMMG
¥26	Description not imput	/AXLE	/(129)	NLDRV	1	AVZG
GZG	Description not input	/AXLE	/(130)	NLDRY	1	AGZG
1726	Description not input	/AXLE	/(131)	MLDRY	1	APZG
MZG	Description not input	/AXLE	/(132)	NLDRV	1 .	AMZG
9(884\84)\9	, The first entry in a 4x8 matrix that contains ∂(δα/δγ)/∂≠	/AXLE	/(133)	NLDRY	1	AVVP
MYP	Description not imput	/AXLE	/(136)	NLDRY	i	ARVP
NGP .	Description not input	/AXLE	/(137)	NLDRV	1	AVGP
MGP	Description not input	/AXLE	/(140)	MLDRY	1	AMGP
IVPP	Description not input	/AXLE	/(141)	NLDRY:	I	AVPP
MPP	Description not imput	/AXLE	/(144)	NLDRY	1	AMPP
9(8°4\2A)\9	h The first entry in a 4x8 matrix that contains ∂(δa/δy)/∂h	/AXLE	/(165)	APP LY NLDRY	0	RVVR
NGVR	Description not input	/AXLE	/(166)	APPLY NLDRY	0	AGVR AGVR
NP VR	Description not input	/AXLE	/(_167)	APPLY	0 1	AP VR
AVR	Description not input	/AXLE	/(168)	APPLY NLDRY	ň	AMVR AMVR
VGR	Description not imput	/AXLE	/(169)	NLDRY	I	AVGR
MGR	Description not input	/AXLE	/(172)	NLDRY	1	AMGR
YPR	Description not imput	/AXLE	/(173)	MLDRY	1	AVPR
MPR	Description not imput	/AXLE	/(176)	MLDRY	1	AMPR
VAR	Description not input	AXLE	/(177)	APPLY NLDRY	O	AVRR
GRA	Description not input	/AXLE	/(178)	APPLY NLDRY	0	AGRR AGRR
PRR	Description not input	/AXLE	/(179)	APPLY NLDRY	0	APRR APRR
MRR	Description not input	/AXLE	/(180)	MLDRY	0	AMRR
VAR .	Description not input	/AXLE .	/(189)	APPLY NLDRY	M I	AVMR AVMR
GMR	Description not input	/AXLE	•	APPLY NLDRV	M I	AGMR AGMR
P MR	Description not input	/AXLE	/(191)	APPLY NLDRY	M	AP MR
MMR	Description not input			MLDRY	1	AMMR
VZR	Description not input	**		NLDRY	1	AVZR
GZR	Description not input			NLDRY	1	AGZR
PZR	Description not input			NLDRV	I	APZR
MZR	Description not input			NLDRV	1	AMZR
VÝO	Description not input			NLBRY	I	AVVE
MVO	Description not input			NLDRY	I	AMVO
V60 M60	Description not input			MLDRY	I	AVSO
VPO	Description not input			NLBRY	I.	AMEO
TTU	Description not input The first entry in a 4x8 matrix that contains		/(205) /(207)	NLDRY	1	AVPO

ORTRAN Symbol	MATH Symbol		DESCRIPTION	STORA BLOCK	LOC	SUBRO!	CODE	USAG
AMPO		Description not	Input	/AXLE /C	208)	NLDAV	1	AMPO
AVRD		Description not	input	/AXLE /	209)	NLDRV	1	AVRD
AMRO		Description not	input	' /AXLE /(212)	NLDRV	I	AMRO
00VA		Description not	input	/AXLE /(213)	NLDRV	I	AVOD
00MA		Description not	input	/AXLÉ /(216)	NLDRY	I	0.0ma
AVVU	η6\(V8\ ^v εδ)6	The first entry ∂(δα/δγ)/∂μ	in a 4x8 matrix that contains	/AXLE /(239)			,
AVVM		Description not	input	/AXLE /C	261)	APPLY NLDRY		MYVA
AGVA	•	Description not	Input	/AXLE /(262)	APPLY	1	AGVA
AP VM		Description not	·	/AXLE /(APPLY NLDRY	1	ap va ap va
AMVM	•	Description not	·	/AXLE /(NLDRY	-	AHVM
AVGM		Description not	•	/AXLE /(MEDRA	I	AVSA
AMGM		Description not		/AXLE /(WEDRY	I	AMGM
AVPR		Description not	•	/AXLE /(_	MEBBA	1	AVPR
AVVM	a6\(V3\ ^v e3)6	3(6s/6y)/3s	in a 4x8 matrix that contains	/AXLE /(271)			
AMPM		Description not		AXLE /		NLDRV	-	AMPM
ARRA		Description net	•	/AXLE /(APPLY NLDRY	I	AVRM
AGRM APRM		Description not		/AXLE /(APPLY NLDRY	I	AGRM AGRM APRM
Mrnn ,,		Description not	INDUC	/AXLE /(2171	APPLY NLDRV	0	APRM
AMRM		Bescription not	Input	/AXLE /	276)	NLBRY	1 .	MARK
AVOM		Description not	Input	/AXLE /(277)	NLDRV	1	AVOM
AMOM		Description not	· ·	/AXLE /(MLDRY		MGRA
AVMM		Description not	Input	/AXLE /		APPLY	D	MAYA
AGMM		Description not	Input	/AXLE /	286)	APPLY NLDRY	0 1	AGMA AGMA
APMM		Description not	input	/AXLE /(287)	APPLY NLDRY	0 1	APMM APMM
AMMM		Description not	Input	/AXLE /(288)	NLDRY	1	ARRA
AVZŘ		Description net	Inpút	/AXLE /(289)	NLDRY	ī	AVZM
AGZM		Description not	Input	/AXLE /(296)	NLDRY	1	AGZA
APZM		Description not	input	/AXLE /(291)	MLDRY	1	APZM
AMZM	•	Description not	Input	/AXLE /(2921	NLORY	1	AMZM
AVVZ		Description not	input	/AXLE /(293)	NLBRY	I	AVVZ
AGVZ		Description not	Input	/AXLE /(294)	NLDRV	1	AGVZ
APVZ		Description not	Input	/AXLE /(295)	NLDRY	I	APVZ
AMVZ		Description not	Input	/AXLE /	296)	NLDRV	1	AMVZ
AVGZ		Description not	Input	/AXLE /(297)	NLDRV	1	AVGZ
AMGZ		Description not	Input	/AXLE /	300)	MLDRY	I	AMGZ
AVPI		Description not	-	/AXLE /		MLDRY	ī	AVPZ
AVVZ	∂(δa ^v /δV)/∂τ	•	in a 4x8 matrix that contains	/AXLE /			-	
AMPZ		Description not	Input	/AXLE /(304)	NLDRY	1	AMPZ
AVRZ		Description not		/AXLE /	305)	NLDRV	1	AVRZ
AGRZ		Description nat	•	/AXLE /		NLDRY	ı	AGRZ
APRZ		•		• •			-	APRZ

FOŘÍRAM Symbol	MATH Symbol		DESCRIPTION	STO BLOCK	PAGE	0 C	<u> 5 </u>	COOL	USAGE
AMR Z		Description not	input	/AILE	/(3	3G8)	NLDRY	I	AMRZ
AVOZ		Description not	Input	/AXLE	/(3	309)	MFDHA	ı	AVOZ
AMO Z		Description not	imput	/AXLE	/(3	312)	MLDRY	i	ARDZ
AVMZ		Description not	input	/AXLE	/(3	317)	NLDRY	1	AVAZ
AGRI		Description not	laput	/AXLE	/(3	(81	MLGRA	ı	AGAZ
APMZ		Description not	input	/AXLE	/(3	319)	MLDRY	ı	AP MZ
AMMZ		Description net	impot	/AXLE	/(3	326)	NLDRY	I	AMMZ
AVZZ		Description not	input	/AXLE	/(3	321)	MLORY	1	AVZZ
AGZZ .		Description not	Input	/AXLE	/(3	322)	NLDRY	1	AGZZ
APZZ		Description not	input	/AXLE	/(3	323)	NLDRY	1	APZZ
AMZZ		Description not	input	/AXLE	/(3	324)	MLDAA	I	AMZZ
AVLV		Description not	input	/AXLE	/(3		APPLY NLDRY	i	WAFA
AGLY		Description not	input	/AXLE	/(3	326)	NLDRY	1	AGLY
APLV		Description net	imput	/AXLE	/(3	327)	MLDRY	I	APLV
AMLV .		Description not	input	/AXLE	/(3	128)	NLDRY	I	AMLV
AYLG	•	Description not	input	/AXLE	/(3	129)	MLDRY	1	AVLG
AGLG		Description not	Input	/AXLE	/(3		APPLY MLDRY	M I	AGLG AGLG
APLG	٠	Description not	Input	/AXLE	/(3		APPLY	ñ	APL6 APL6
AMLG		Description not	imput	/AXLE	/(3	332)	MLDRY	ī	AML6
AVLP		Description not	Input	/AXLE	/(3	333)	NLDRV	1	AVLP
AGLP		Description not	inpet	/AXLE	/(3		APPLY NLDRY	Ħ	aglp aglp
AVLV	9a ^v /9X _v	The first entry da/dh, and da/dh	in a 9x3 matrix that contains ∂a/∂λ _y ,	/AXLE	/(3		APPLY MLDRY	· M	APLP APLP
AMLP	•	Description not	input	/AILE	/(3	36)	MLORY	ı	AMLP
AYLY		Description not	Imput	/AXLE	/(3		MLDRY	1	WANTA
AGYLY		Description not	input	/AXLE	/(3	38)	NLORY	1	AGAFA
APVLV		Description not	inpat	/AXLE	/(3	139)	NLDRY	I	APVLV
AMVLV		Description not	input	/AXLE	/(3	100	NLDRY	1	AMAFA
	a ₄ \εΑ)\9y ⁴	The first entry ∂(δa/δy)/∂λ	in a 4x8 matrix that contains	/AXLE	/(3	347)			
AVRLV	•	Description not	Impet	/AXLE	/(3	349)	MLDRV	1	AVRLV
AGRLY		Description nat	Input	/AXLE	/(3	350)	NLDRY	1	AGRLY
APRLV		Description not	input	/AXLE	/(3	351)	MFDBA	1	APRLV
ARRLV		Description not	Imput	/AXLE	/(3	352)	NLÒRY	1	AMRLY
AVALV		Description nat	input	/AXLE	/(3	361)	NLDRY	1	AVALV
AGMLV		Description mat	input	/AXLE	/(3	362)	NLDRY	1	ASMLY
APMLY		Description not	Input	/AXLE	/(3	363)	NLDRY	1	APMLV
AMMLV		Description not	input	/AXLE	/(3	369)	MLDRY	ī	AMMLY
AVZLV		Description not	input	/AXLE	/(3	165)	NLORY	·	AVZLV
AGZLV		Description not	Input	/AXLE	/(. 3	366)	NLDRY	ı	ASZLV
APZLV		Description not	input	/AXLE	/(3	167)	NLDRV	ı	APZLV
AMZLV		Description met	Imput	/AXLE	/(3	1888	MLDRV	1	AMZLY
AVVLG		Description not	•	/AXLE	/(3	169)	NLORY	ī	AVVLG
AGVLG		Description not	·			170)	APPLY NLBRY	0	AGYLG
APVLG		Description not	input .	/AXLE	/(3	371)	APPLY NLDRY	B I	APVLS

FORTRAN Symbol	MATH Symbol		DESCRIPTION	BLOCK	LOC	SUBADI	CODE	USAGE VAR
				· · · · · · · · · · · · · · · · · · ·				
AMVLG		Description not	Input	/AXLE /	372)	NLDRY	1	AMVLG
AVVLG	9(8a*/8V)/9y	The first entry a(6=/6y)/ax,	In a 4x8 matrix that contains	/AXLE /	(379)			
AVRLG		Description not	input	/AXLE /	(381)	NLDRY	i	AVRLG
AGRLG		Description not	Input	/AXLE /	(382)	APPLY NLDRY	0	AGRLG AGRLG
APRL6		Description not	input	/AXLE /	(383)	APPLY NLDRY	0	APRL6
AMRLS		Description not	input	/AXLE /	(384)	NLDRY	1	AMRLG
AVMLG		Description not	Input	/AXLE /	(393)	NLDRY	1	AVMLS
AGMLG		Description not	Input	/AXLE /	(394)	APPLY NLDRV	0	ASMLS ASMLS
APMLG		Description not	Imput	/AXLE /	(395)	APPLY NLDRY	0 1	APMLG APMLG
AMMLG	,	Description not	input	/AXLE /	(396)	NLDRY	. 1	AMMLG
AVZLG		Description not	Input	/AXLE /	397)	NLBRY	1	AVZLG
ASZLG		Description not	input	/AXLE /	(398)	NLDRV	I	AGZLG
APZLG		Description not	input	/AXLE /	(399)	NLDRV	I	APZLG
AMZLG		Description not	input	/AXLE /	(400)	NLDRY	I	ARZLG
AVVLP		Description not	input	/AXLE /	(401)	NLDRY	I	AVVLP
AGAFL		Description not	Input	/AXLE /	(402)	APPLY NLDRY	0	WEATL
APVLP		Description not	Input	/AXLE /	(403)	APPLY NLDRY	0	APVLP APVLP
AMVLP	*	Description not	Input	/AXLE /	(404)	MLDRY	I	AMVLP
AVVLP	∂(δ° ₄ \εΛ)\9γ [*]	The first entry ∂(δε/δγ)/∂λω	in a 4x8 matrix that contains	/AXLE /	(411)			
AVRLP	•	Description not	input	/AXLE /	(413)	NLDRY	1	AVRLP
AGRLP		Description not	Input	/AXLE /	(414)	APPLY NLDRY	0 I	AGRLP AGRLP
APRLP		Description not	Input	/AXLE /	(415)	APPLY NLDRY	8 I	APRLP APRLP
AMRLP		Description not	input	/AXLE /	(416)	NLDRY	1	AMRLP
AVMLP		Description not	input	/AXLE /	(425)	NLDRY	I	AVMLP
AGMLP		Description not	Input	/AXLE /	(426)	APPLY NLDRY	0	AGMLP AGMLP
APMLP		Description not	Input	/AXLE /	(427)	APPLY NLDRY	0 I	APMLP APMLP
AMMLP		Description not	input	/AXLE /	(428)	NLDRY	1	AMMLP
AVZLP		Description not	•	/AXLE /	(429)	NLDRY	1	AVZLP
AGZLP		Description not	Input	/AXLE /	(430)	NLDRV	I	AGZLP
APZLP		Description not	input	/AXLE /	(431)	NLDRY	1	APZLP
AMZLP		Description not	Insut	/AXLE /	(432)	NLDRV	1	AMZLP

BLØCK BICUBE

ORTRAN Symbol	MATH Symbol	DESCRIPTION	STORA:	LOC -	SUBRO	UTINE CODE	USAGI
3111600	2411000		acco.		3000	CODE	7
AMI N	*o	The smallest value of the first independent variable of a bivariate table.	/81CU8E/(1)	BLINE	I	AMIN
AMAX	×N	The largest value of the first independent variable of a bivariate table.	/BICUBE/(2)	BLINE	1	AMAX
1 F		Last file in the grid in which interpolation occurred.	/81EUBE/(3)	BLINE	M	1F
1 FMAX	N	Total number of files in grid.	/BICUBE/(4)	BLIME	1	IFMAX
AMI N	Yo	The smallest value of the second independent variable of a bivariate table,	/81 CUBE/(5)	BLINE	1	MAIN
XAME	y m	The largest value of the second independent variable of a bivariate table,	/81CU8E/(6)	BLINE	I	MMAX
I R		Last rank in the grid in which interpolation occurred.	/BICUBE/(7)	BLINE	M	18
I RMAX		Total number of ranks in grid.	/BICUBE/(8)	BLINE	1	IRMAX
IUNIT		Logical unit number on which bicubic spline coefficients are stored for this table.	/BICUBE/(9)	BLIME	I	IUNIT
IRECT		Grid rectangle associated with IR and IF.	/B1CUBE/(10)	BLINE	R	IRECT
IREC		Logical record on IUMIT that contains spline coefficients for rectangle IRECT.	/BICUBE/(11)	BLINE	Ħ	IREC
C		A 32 word array containing the spline coefficients for the two bivariate functions at rectangle IRECT.	\BICUBE\(12)	BLINE		CLOO
CL10		Description not input	/BICUBE/(13)	BLINE	1	CL10
CL20		Description not input	/81CU8E/(14)	BLINE	1	CL20
CL30		Description not input	/BICUBE/(15)	BLINE	1	CL30
CLOI		Description not imput	/BICUBE/(16)	BLINE	I	CLO1
CLII		Description not imput	/BICUBE/(17)	BLINE	1	CL11
CL21		Description not input	/81CU8E/(181	BLINE	ι	CL21
CL31		Description not input	/81CU8E/(19)	BLINE	ī	CL31
CL02		Description not input	/BICUBE/(20)	BLINE	I	CL02
CL12		Description not input	/BICUBE/(21)	BL1NE	I	CL12
CL22		Description not imput	/BICUBE/(22)	BLINE	I	CL22
CL32		Description not input	/BICUBE/(23)	BLINE	1	CL32
CL03		Description not input	/BICUBE/(24)	BLINE	I	CF03
CL13		Description not input	/BICUBE/(25)	BLINE	1	CL13
CL23		Description not input	/BICUBE/(26)	BLINE	1	CL23
CL33		Description not input	/BICUBE/(27)	BLINE	1	CL33
CDOO		Description not input	\BICDBE\(28)	BLINE	1	CDOO
CD10		Description not input	/BICUBE/(29)	BLINE	ı	CD10
CD20		Description not Input	/BICUBE/(30)	BLINE	I	CD20
CD30		Description not input	/BICUBE/(BLINE		CD30
CDO1		Description not input	/BICUBE/(BLINE		CDO1
CDII		Description not input	\BICABE\(BLINE		CD11
CD21		Description not Input,	/BICUBE/(BLINE		CD21
CD31		Description not imput	/BICUBE/(BLINE		CD31
CD02		Description not input	/BICUBE/(BLINE		CDO2
CD12		Description not input	/81CU8E/(BLINE	_	CD12
CD22		Description not input	/BICUBE/(BLINE		CD22
CO32		Description not input	/BICUBE/(BLINE		CD32
CD03		Description not input	/BICUBE/(BLINE		CD03
CD13		Description not input	/BICUBE/(BLINE		CD13
CD23		Description not input	/BICUBE/(BLINE		CD23
CD33		Description not input	/BICUBE/(43)	BLINE	. 1	CD33

FORTRAN Symbol	MATH Symbol	DESCRIPTION	STORAC BLOCK	GE LOC	SUBADI Suba	COD	USAGE VAR
ALFA		A 31 word array containing the wesh x_0 , x_1 ,, x_n	/81CUBE/(204)	BLINE	i	ALFA
MACH		A 31 word array containing the mesh yo, y1,,yn	/81CU8E/(235)	BLIME	ĭ	MACH

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BLØCK BLØCK

FORTRAN Symbol	MATH Symbol	DESCRIPTION	STORAGE Block Loc	SUBROUTINE USAGE SUBR CODE VAR
110		A 10x20 array containing the initial condition codes for the QL state vector. The columns correspond to subarc starting points, the rows, to QL state veriables.	/8LOCK /(1	BCOND M IIC BRANPT I IIC CHECK I IIC COSTAB I IIC COSTAB I IIC COSTAB I IIC COSTAB I IIC STALVE I IIC
1107		A 10×20 array containing the target condition codes for the state vector. The columns correspond to the subarc end points. The nonzero entries in a column are the state target condition codes that apply at the end of the corresponding subarc.	/8LOCK /(201	CHECK I LICT COSTAB M LICT COSTAI M LICT COSTAO O LICT MAGIC O LICT SALVE I LICT
ITC		A 10x20 array containing the initial condition codes for the GL costate vector. The columns correspond to subarcistarting points, the roms, to GL costate variables.	/8LGCK /(401	BCOMB O ITC BRANPT I ITC CHECK I ITC COSTAB I ITC COSTAI I ITC EMDPT I ITC INTRPT I ITC
JTAB		An array containing the number of nonzero entries in each column of the array IICT.	/8LOCK /(601	BCOND M JTAB BRAMPT I JTAB CHECK I JTAB COSTAB I JTAB COSTAB I JTAB COSTAI I JTAB ENDPT I JTAB INTRPT I JTAB MAGIC I JTAB
ITCT		A 10x20 array containing the QL costate analog to the array IICT. The columns correspond to subarc end points. The nonzero entries in a column are the numbers of those components of the vector B in Equation 16.6-34 of Volume I of the PADS document that contain the value of a costate target condition that applies at the end of the corresponding subarc.	/BLOCK /(621	BCOND O ITCT BRANPT I ITCT CHECK I ITCT COSTAB O ITCT COSTAI O ITCT INTRPT I ITCT MAGIC O ITCT
LTAB		An array containing the number of monzero entries in each column of the array ITCT.	/BLOCK /(821	D BCOND O LTAB BRANPT I LTAB COSTAB O LTAB COSTAI O LTAB INTRPT I LTAB MAGIC M LTAB
NOKNOW		The total number of free (unknown) state and costate variables over all the subarcs.	/BLOCK /(841	CHECK I NOKNOW COHOMO I MOKNOW COSTAB M NOKNOW COSTAB M NOKNOW GROPE I MOKNOW MAGIC I NOKNOW MAGIC I NOKNOW
NOC		An array containing a running total of the number of free (unknown) state and costate variables at the start of each subarc.	/BLOCK /(842	D BNDRY I MOC BRANPT I NOC COSTAB O MOC COSTAI O MOC COSTAO O NOC INARC I MOC INTRPT I MOC SALVE I MOC SALVE I MOC WRAPUP I MOC
VALIC		A 10x20 array containing the desired values of all the fixed (known) OL state variables. The columns correspond to the subarc starting points, the rows, to OL state variables.	/BLOCK /(862	
VALTC		A 10x20 array containing the desired values of the state target conditions whose codes appear in the array IICT.	/BLOCK /(1062	DECEMB O VALTO BRAMPT I VALTO CHECK I VALTO ENDPT I VALTO INTERPT I VALTO

FORTRAM	MATH	DESCRIPTION	STORAGE SUBROUTINE USAGE
Symbol	Symbol		BLOCK LOC SUBR CODE VAR
1PAY		Description not input	/BLOCK /(1262) BCOND O IPAY ENOPT I IPAY INTRPT I IPAY

BLØCK CNTRL

FORTRAN	MATH	DESCRIPTION	\$10F		SUBRO	TIN	USAGE
SYMBOL	SYMBOL	DECONTI TION,	BLOCK	FOC	SUBA	COD	VAR
NU		The largest number of quantities requiring numerical integration per QL iteration.	/CNTRL /	(1)	CHECK	0	MU
ITER		OL Iteration number.	/CNTRL /	(2)	ETIME GROPE OUTPUT	M M	ITER ITER ITER
1TAPA		Number of the logical unit containing the quasitime histories of the particular and homogeneous solutions from the preceding QL iteration.	/CNTRL /	/(3)	GROPE		ITAPA ITAPA
ITAPB		Number of the logical unit onto which the quasitime histories of the particular and homogeneous solutions from the current QL iteration are written.	/CMTRL /	/(4)	GROPE Salve	e	ITAPB ITAPB
JMIN		Not used.	/CHTRL /	(5)			
XAML		Not used.	/CHTRL /	(6)			
LINES		Not used.	/CHTRL /	(7)	CHECK	8	LIMES
KPT		The subarc point number. KPT = 1 on the first point of subarc, and KPT = NPTS on the last point of the subarc.	/CNTRL /	r(8)	BCOND BNDRY FORCES MAGIC RKUTTI SALVE WRAPUF	0	KPT KPT KPT KPT KPT KPT
MOM		The number of homogeneous solutions currently being integrated.	/CNTRL /	/(9)	GROPE INARC LINDRY NOMNAL SALVE WRAPUR	1 .	MOM MOM MOM MOM MOM MOM
KARD		The total number of homogeneous solutions eventually to be integrated.	/CNTRL /	(10)	CHECK	n	KARD
INDX		An array of four words that indicate to Adams-Moulton integration in what order the derivatives of the particular and howogeneous solutions are stored.	/CHTRL /	/(11)	BCOND MADAMS SALVE		I NOX I NDX I NDX
NEWNOM		A logical flag that indicates to the Runge-Kutto integration whether or not the system Jacobian needs to be reevaluated.	/CNTRL /	/(15)	INTERI LINDRI RKUTT: SALVE WRAPU	V M 1 6	MEMNOW MEMNOW MEMNOW MEMNOW
CNT016		Not used.	/CNTRL /	(16)			
RHOC		The magnitude of the error in the current OL iteration.	/CNTRL /	(17)	CHECK GROPE	0	RHOC RHOC
RHOP		The magnitude of the error in the preceding QL iteration.	/CNTRL /	(18)	CHECK GROPE	0	RHOP RHOP
MPTS		The total number of points in the suberc.	/CNTRL /	/(19)	BCOND BNDRY FORCES INARC MASIC SALVE WRAPUF	M 0 M	NPTS NPTS NPTS NPTS NPTS NPTS NPTS
MINES		Not used.	/CNTRL /	(20)	CHECK	0	MINES
KPAGE		Not used.	/CNTRL /	(21)	CHECK GROPE	8	KPAGE KPAGE
NNP		Number of QL state and costate variables.(18)	/CNTRL /	(22)	CHECK	, i	NMP NMP
NUP		Same as AU.	/CNTRL /	(23)	CHECK GROPE I MARC	0 I 1	MUP MUP MUP



FORTRAN Symbol	MATH SYMBOL	DESCRIPTION	STORAG BLOCK	LOC	SUBROUTI SUBA CO	NE USAGE DE VAR
IARC	ī	Subarc mumber.	/CMTRL /C	24)	ARCIM I BOUND WE BRANPT I CHECK COSTAI I COSTAI I FONCES I INTRC I INTRC I INTRC I MAGIC MARCU M	I ARC IARC IARC IARC IARC IARC IARC IARC I
TRSTR		Not used.	/CNTRL /(25)	CHECK 1	TRSTR TRSTR
IMAX		Not used.	/CNTRL /(26)		
KTIME		Not used.	/ENTRL /(27)		
KONVER		Logical flag that indicates to the OL module that the OL iteration is converged.	/CNTRL /(28)	ALGCON I APPLY I ARCIN I COHOMO O GROPE O NLORY I OUTPUT I RKUTTI I	KÖNVÉR KONVER KONVER KONVER
HOPRHT		Not used.	/CMTRL /(29)	OUTPUT M SALVE O TRAJIM O	NOPROT
INBDRY		Not used.	/CHTRL /(30)	CHECK 0	INBORY
MUPAGE		Not used.	/CMTRL /(31)		
I VARY		Twenty word array not used.	/CMTRL /(32)	`	
		The number of quantities currently being numerically integrated.	/CNTRL /(52)	BNDRY MINARC MADAMS I MAGIC MOMMAL I RKUTTI I RKUTTZ I SALVE MURAPUP M	MEN. 9445 1 1945 1450 MEN. 1970
NOVARY		Not used.	/CNTRL /(53)		
PLAST		Not used.	/CNTRL /(54)		
ZLAST		Not used.	/CNTRL /(55)		
KODES		Not used.	/CHTRL /(56)	GROPE O NLDRY M WRAPUP O	KODES

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BLØCK D

ORTRAN Symbol	MATH Symbol	DESCRIPTION	ВС	STORAC DCK	LOC	SUBROU SUBR	CODE	USAG VAR
X.	x	The quesitime variable.	/0	16	11	AL4 BNDRY ERROR FETCH FORCES INTERP INTERPO IN	0 1 0 1 M M M M M M	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
N	h	Integration step size in quasitime.	/0	/(2)	AL4 INARC MADAMS RKUTT1 RKUTT2 SALVE WRAPUP	I 	M M M M M M DT
X I		A four word array containing the first four values of quasitime in the subarc.	/0	/(3)	INTERP SALVE		X I
MAGBY		The magnitude of all of the decired values of the state target conditions.	/D	/(7)	NEMC? CHECK	Ħ I	MAGBY MAGBY
ERR		Convergence criterion of iteration for the c's.	/ D	/(. 8)	CHECK		ERR Err
D 9		Not used.	/0	/(9)			
010		Hot used.	/0	/(10)			
C		A forty word array containing the vector of c's, i.e the multipliers for the homogeneous solutions.	. /0			BNDRY BRANPT GROPE INTRPT NEWCS NLDRY NOMNAL WRAPUP	I I I M I	00000000
CSAVE		A forty word array nat used.	/0	/(51)			
	•	Relative velocity. (FT/SE				AL1 AL7 AL8 AL9 BCOND BRORY BRANPT ENUPRO ENUPRO INTERP IN	I	A A A A A A A A A A A A A A A A A A A
NOM		A twenty word array containing the state and costate vectors.	/8	/(91)			
GAM	7	Relative flight path angle. (RAI	0) /0	/(92)	ARCIN ENVPRO OUTPUT STATEF WRAPUP	1 1 1	GAM GAM GAM GAM GAM
PS1	*	Relative azimuth angle. (RAI	0) /0	/(93)	OUTPUT	I	PSI PSI

FORTRAN Symbol	MATH Symbol	DESCRIPTION		810C	DRAGE LOC	SUBROUTIA SUBR COC	E USAGE
ALT	h	Altitude	(FT)	/0	/(94	OUTPUT I STATEF I WRAPUP I	ALT ALT ALT
R HO	ρ	Latitude	(RAD)	/0	/(95	OUTPUT I STATEF I WRAPUP I	RHO RKO RHO RHO
MU	μ	Relative longitude	(RAD)	/0	/(96	OUTPUT I POBCQL I WRAPUP I	ศบ ศบ ศบ
•	•	Mess	(6'5)	/0	/(97	ALT I ALE I ALE I ALE I ALE I ALE I ALE I COSTAB I COSTAB I INTRPT I NUTRET I SALVE I STATEF I STATEF I MRAPUP I	用
TAU	7	Subarc duration	(SEC)	10	/(98) ARCEM 'I INARC M MLDRY I OUTPUT I STATEF I	TAU TAU TAU TAU TAU
нт	٥	Meating	(BTU)	/D	/(99	OUTPUT I	NT NT
LV	λ,	Relative velocity costate		/D	/(100) ALI I CONTRL I NLDRY I NPLANE I OUTPUT I WRAPUP I	FA FA FA FA FA
LGAM	λ,	Relative filght path angle costate			/(101	ALI I ARCIM I COMTRL I NLDRY I OUTPUT I WRAPUP I	LGAM LGAM LGAM LGAM LGAM
LPSI	λ.,	Relative azimuth angle costate		/0	/(102	ALI I ARCIN I CONTRL I NLORV I OUTPUT I WRAPUP I	LPSI LPSI LPSI LPSI LPSI LPSI
LR	$\lambda_{\mathbf{R}}$	Altitude costate		/0	/(103) NLDRY I OUTPUT I WRAPUP I	LR LR LR
LRHO	λ	Latitude costate		/0	/(104	NLDRV I OUTPUT I WRAPUP I	LRHO LRHO LRHO
LMU	λ_{μ}	Relative longitude costate		/D	/(105) MLDRV I OUTPUT I WRAPUP I	LAU LAU LAU
LM	λ_{ullet}	Mass costate		10	/(106) NLDRY I OUTPUT I WRAPUP I	LM LM LA
LTAU	λ,	Subarc duration costate		/0	/(107	OUTPUT I	LTAU
LHT	λ	Heating costate		/0	/(108) NLDRV I WRAPUP I	LHT
0109	G. 01-47	Not used ,		/0	/(109		

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FORTRAN Symbol	MATH Symbol	DESCRIPTION	BLO	STORA(LOC	SUBROU SUBR		USAGE VAR
D110	- *	Not used.	/D	/(110)			
BV		A forty word erray not used.	10	/(111)			
ZSAVE		A twenty word array containing the values from the initial arc of the state and costate at the initial point of the trajectory.	/0	/(151)	BCOND BRANPT COSTAB COSTAI INTRPT PDBCQL SALVE	I I	ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE
QT		A twenty word array containing the values from the initial arc of the successive subarcs' durations	10	/(171)	INARC WRAPUP	0	OT OT
NPOINT		A twenty word array containing the number of points in each subarc.	/0	/(191)	INARC Salve	0	NPOINT NPOINT
DELT		A twenty word array containing the quasitime compute interval for each subarc.	/0	/(211)	CHECK ERROR IMARC	0	DELT

BLØCK DYNA

ORTRAN SYMBOL	MATH Symbol	DESCRIPTION	· · · · · · · · · · · · · · · · · · ·	S T BLOC	OR A GE	LOC	SUBROUTI SUBR CO	NE USAGE DE VAR
xx		Fraction of subarc that has transpired		/DYNA	/(1)	ARCIN OF ERROR IN OUTPUT IN STATEF	XX
TIME		Trajectory time	(SEC)	/DYNA	/(2)	ENVPRO I OUTPUT I POBCOL I STATEF # WRAPUP I	TIME TIME TIME
SINGAM	sin7	See symbol		/DYNA	/(3)	AL1 I AL4 I AL7 I AL8 I CONTRL I NLDRV I POBCOL I STATEF P	PAGNIZ RAGNIZ RAGNIZ RAGNIZ RAGNIZ RAGNIZ RAGNIZ
COSGAM	C 0 S 7	See symbol .		/DYNA	/(4)	ALI II AL4 II AL7 II AL8 II AL9 II CONTRL II NLDRY II OUTPUT II PDBCQL II STATEF	COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM
OMEGA	•	Earth rotation rate	(RAD/SEC)	/DYNA	/(5)	AL4 1 AL7 1 CONTRL 1 POBCOL 1 TRAJIN P	OMEGA OMEGA OMEGA
OME GA2	2 س	See symbol,		/DYNA	/(6)	AL9 1 AL7 1 AL8 1 AL9 1 NLDRV 1 TRAJIN 0	OMEGA2 OMEGA2 OMEGA2 OMEGA2
R	R	Radial distance from earth center to vehicle	(FT)	/DYNA	/(7)	AL4 1 AL7 1 AL8 1 AL9 1 CONTRL 1 ENVPRQ 1 NLDRV 1 PDBCQL 1 QLTOSZ 1 STATEF #	R R R R R R
G	g	Instantaneous gravitational acceleration	(FT/SEC ²)	/DYNA	/(8)	AL4 J AL7 J AL8 I AL9 J CONTRL I NLDRY I STATEF	6 6 6
SINA	sina	See symbol		/DYNA	/(9)	ALI I AL4 I AL6 I AL7 I ALB I AL9 I ALP I CONTRL I COUTPUT I TH3 I UT	SINA SINA SINA SINA SINA SINA SINA SINA



FORTRAN Symbol	MATH Symbol	DESCRIPTION		5.1 8L0C	ORAG (LOC	SUBROU SUBR	COD	E VAR
COSA	cοsα	See symbol		/DYNA	/(10)	AL1 AL4 AL6 AL7 AL9 APPLY CONTRL NLDRY OUTPUT TH3 UT	1	COSA COSA COSA COSA COSA COSA COSA COSA
DYN011		Not used.		/DYNA	10	11)			
OMEGAT	2 🕳	See symbol		/DYNA	/(12)	NLDRV TRAJIN	1	OMEGAT OMEGAT
TAMP	۲,	Atmospheric temperature	(DEG-R)	/DYMA	/(13)	STATEF		TAMP
PA	Pa	Atmospheric pressure	(LBS/FT ²)	/DYNA	/(14)	IMPULS NLDRY OUTPUT TH2	1	PA PA PA
RO	Pa	Atmospheric density	(SL6S/FT ³)	/DYNA	/(15)	AL7 AL8 AL9 NLDRV OUTPUT PDBCQL STATEF	1	RO RO RO RO RO RO
CS	•	Speed of sound	(FT/SEC)	/DYNA	/(16)	OUTPUT STATEF		CS CS
TEMPR	∂T_/∂R	See symbol		/DYNA	/(17)			
PAR	ap /ar	See symbol		/DYNA	/(18)	APPLY TH2	I I	PAR PAR
ROR	∂ρ _∎ /∂R	See symbol		/DYNA	/(19)	AL7 AL8 AL9 NLDRV PDBCQL STATEF	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	ROR ROR ROR ROR ROR
CSR	aa/aR	See symbol		/DYMA	/(20)	STATEF		CSR
TEMPRR	a ² T_/aR ²	See symbol		/DYNA	/(21)			
PARR	∂ ² P_/∂R ²	See symbol		/DYNA	/(22)	APPLY TH2	1 1	PARR PARR
RORR	$\partial^2 \rho_{\bullet}/\partial R^2$	See symbol		/DYNA		23)	AL7 ALB AL9 NLDRV STATEF	1 1 1 1	RORR RORR RORR RORR
CSRR	a ² a/aR ²	See symbol		/DYNA	/(24)	STATEF	I	CSRR
KODE	3 2. 2	Steering vector fing KODE = 0: Free fail, $\alpha = \phi = 0$; KODE = 1: Both α and θ aptimal; KODE = 2: α optimal and $\phi = 0$; KODE = 3: α nonoptimal and θ optimal; KODE = 4: Vertical rise or pitchover; KODE = 5: α nonoptimal and $\theta = 0$.		/DYNA	/(25)	APPLY ARCIN CONTRL FORCES NLDRY STATEF	I	KODE KODE KODE KODE
MACH	M	Mach number	•	/DYNA	/(26)	AEROCO ENVPRO OUTPUT STATEF	I	MACH MACH MACH

ORTRAN Symbol	MATH Symbol	DESCRIPTION		BLOC	ORAGI	LOC	SUBROUTI SUBR CO	NE USAG DE VAR
0	9	Oynamic pressure	(LB5/FT ²)	/DYWA	/(27)	ENVPRO 1 OUTPUT I POSCOL 1 STATEF #	0 0 0
0 V	94/9V	See symbol		/DYNA	/(28)	POBCOL I STATEF M	QV
98	94/9R	See symbol		/DYNA	/(29)	PDBCOL 1 STATEF M	en .
5 4 A	a ² q/av ²	See symbol		/DYNA	/(30)	STATEF M	644 644
9 VR	a ² q/avaR	See symbol		/DYNA	/(31)	STATEF M	QVR
ann .	9 ² q/9R ²	See symbol		/BYNA	16	32)	STATEF M	g vr grr
FVAC		Total vacuum thrust (recket)	(LBS)	/DYMA	/1		APPLY I ARCIN MIMPULS MILORY I STATEF MILORY I	FVAC FVAC FVAC
FVACV		Not used.		/DYNA	/(34)		
FVACR		Not used.		/DYNA	/(35)		
AVCM		Not used.		/DYNA	/(36)		
VACT		Not used.		/DYNA	/(37)	ARCIN I STATEF M TH2 I	FVAC'
FVACVV		Not used.		/DYNA	/(38)		
FVACVR		Not used.		AMA	/(39)		
FVACRR		Not used.		/DYNA	74	40)		
FVACTT		Not used.		/DYNA	/(41)	ARCIN 1 STATEF M TH2 1	FVACT FVACT
ī	T	Thrust	(LBS)	/DYNA	/(42)	ALGCON MALI II AL4 II AL6 II AL6 II AL7 II ARCIM CONTRL M DL2 II IMPULS I OUTPUT II TM1 II TM2 II TH4 II TH4 II	T T T T T T T T T T T T T T T T T T T
MACHV	94/94	See symbol		/DYNA	/(43)	STATEF M	MACHY
MACHR	am/an	See symbol		/DYNA	/(44)	STATEF A	MACHE
I SP	I _{SP}	Vacuum specific impulse	(SECS)	/DYNA	/(45)	APPLY I ARCIM O IMPULS O	ISP ISP ISP
		Not used.		/DYNA	/(46)		
SPV								
SPV		Not used.		/DYNA	/(47)		•

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DRTRAM	MATH	DESCRIPTION			DRA	GE	SUBROUT	INE	USAG
SYMBOL	SYMBOL	DESCRIFTION		BLOC	<u> </u>	LÜÜ	SUBR C	ODE	VAR
ISPT		Not used.		/DYNA	/(49)			
ISPVV		Not used.		/DYNA	/(50)			,
SPVR		Not used.		/DYNA	/(51)			
SPYM		Not used.		/DYNA	/(52)			
SPYT		Not used.		/DYNA	/(53)			
SPRR		Mat used.		/DY NA	/(54)			
SPRM		Not used.		/DYNA	/(55)			
SPRT		Not used.		/DYNA	/(56)			
SPMM		Not used.		/DYNA	/(57)			
SPMT		Not used.		/DYMA	/(58)			
SPTT		Not used.		/DYNA	/(59)			
LIFT	L	Aerodynamic lift	(L85)	/DYNA	,	60)	AL5 AL6 APPLY CONTRL ENVPRQ OUTPUT TH3	1 1 1 1 1 1	LIFT LIFT LIFT LIFT LIFT LIFT LIFT LIFT
.1FTV	aL/aV	See symbol		/DYNA	/(61)	AL4 AL5 AL6 APPLY TH3	I I I I	LIFTY LIFTY LIFTY LIFTY LIFTY LIFTY
JFTA	∂L/∂R	See symbol		/DYNA	π	62)	AL5 AL6 APPLY TH3	I I I I	LIFTE LIFTE LIFTE LIFTE LIFTE
IFTA	∂L/∂œ	See symbol		/DYNA	/(63)	AL4 AL5 AL6 APPLY TH3	I I I I	LIFTA LIFTA LIFTA LIFTA LIFTA LIFTA
.1FTVV	∂ ² L/∂¥ ²	See symbol		/DYNA	/(64)	AL4 AL5 AL6 APPLY TH3	1 I I I	LIFT LIFT LIFT LIFT LIFT
.IFTVR	a ² L/avaR	See symbol .		/DYMA	/(65)	AL5 AL6 APPLY TH3	1 1 1 1	LIFT LIFT LIFT LIFT LIFT LIFT
.IFTVA	∂ ² L/∂V∂∝	See symbol		/DYNA	/(66)	AL4 AL5 AL6 APPLY TH3	I I I I	LIFTY LIFTY LIFTY LIFTY LIFTY LIFTY
.IFTRR	∂ ² L/∂R ²	See symbol		/DYNA	n	67)	AL4 AL5 AL6 APPLY TH3	I I I I	LIFTF LIFTF LIFTF LIFTF LIFTF



ORTRAN Symbol	MATH 54MBOL	DESCRIPTION		<u>\$ 1</u> 8LOCI	ORAGE LOC	SUBROU SUBR	TINE USAG CODE VAR
LIFTRA	∂ ² L/∂R∂œ	See symbol		/DYNA	/(68)	ALI AL4 AL5 AL6 APPLY TH3 UT	I LIFTA I LIFTA I LIFTA I LIFTA I LIFTA O LIFTA
D##6	D	Aerodynamic drag	(LBS)	/DYNA	/(69)	AL5 AL8 AL9 APPLY CONTRL ENYPRQ NLDRY OUTPUT TH3 UT	I ORAG I DRAG I DRAG I DRAG I DRAG I DRAG I DRAG I DRAG I DRAG I DRAG M DRAG
OR #64	Ve/06	See symbol	·	/BY4A	/(70)	AL5 AL7 ALB AL9 APPLY TH3 UT	I DRAGY
DR A GR	ad/ar	See symbol		/DYNA	/(71)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAGR I DRAGR I DRAGR I DRAGR I DRAGR I DRAGR M DRAGR
DR AGA	∂D/∂¤	See symbol	·	/DYNA	/(12)	AL1 AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAGA ORAGA
DR & SVV	a ² 0/av ²	See symbol		/BY#A	/(73)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAGY I DRAGY I DRAGY I DRAGY I DRAGY I DRAGY A DRAGY
DR A G VR	a ² D/avaR	See symbol		/DYMA	/(74)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAGVI I DRAGVI I DRAGVI I DRAGVI I DRAGVI M DRAGVI
DRAGVA	a ² D/aV∂∝	See symbol	·	/DYNA	/(15)	AL1 AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAGVI I DRAGVI I DRAGVI I DRAGVI I DRAGVI I DRAGVI M DRAGVI
DRAGRR	a ² D∕a¤²	See symbol	· .	/OYNA	/(76)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAGRI I DRAGRI I DRAGRI I DRAGRI I DRAGRI I DRAGRI M DRAGRI

FORTRAN	MATH Symbol	n	ESCRIPTION	510	RAGE	SUBRO	UTINE	USAGE
SYMBOL	SYMBOL		LUCATIVION	BLOCK	COC	SUBR	CODE	VAR
DRAGRA	∂ ² D/ ∂R∂ α	See symbol		/DYNA	/(11	AL1 AL5 AL7 AL8 AL9 APPLY TH3 UT	I I I I I	DRAGRA DRAGRA DRAGRA DRAGRA DRAGRA DRAGRA DRAGRA DRAGRA
DRAGAA	∂ ² D/∂œ ²	See symbol		/DYNA	/(78	AL1 AL5 AL7 AL8 AL9 APPLY TH3 UT	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	DRAGAA DRAGAA DRAGAA DRAGAA DRAGAA DRAGAA DRAGAA
ALPHA	ća	Angle of attack	(RAD)	/DYNA		AEROCI ALGCOI ALZ ARCIN CONTRI ENVPRI MOMECI MPLANI OUTPUT TRAJII UT	N M M M M I M M I M I M I M I M I M I M	ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA
PHI	•	Bank angle	(RAD)	/DYNA	/(80	CONTRI DUTPUT WRAPU	T I	PHI PHI PHI
LIFT#	∂L/∂mi	See symbol		/BYNA	/(81	AL4 AL5 AL6 APPLY TH3 UT	I I I	LIFTM LIFTM LIFTM LIFTM LIFTM LIFTM
LIFTVM	∂ ² L/ ∂V∂ m	See symbol		/DYNA	/(82	AL4 AL5 AL6 APPLY TH3 UT	I I I	LIFTUM LIFTUM LIFTUM LIFTUM LIFTUM LIFTUM
LIFTRM	∂ ² L/∂R∂m	See symbol		/DYNA	/(83	AL4 AL5 AL6 APPLY TH3 UT	I I I I I	LIFTRM LIFTRM LIFTRM LIFTRM LIFTRM LIFTRM
LIFTMM	∂ ² L/∂ s ²	See symbol		/DYNA	/(84	AL4 AL5 AL6 APPLY TH3 UT	1	LIFTMM LIFTMM LIFTMM LIFTMM LIFTMM
LIFTMA	∂ ² L/∂ m ∂α	See symbol .		/DYNA	/(85	AL1 AL4 AL5 AL6 APPLY TH3 UT	I I I I I	LIFTMA LIFTMA LIFTMA LIFTMA LIFTMA LIFTMA

FORTRAN Symbol	MATH Symbol	DESCRIPTION		BLOCK	ORA	LOC	INE USAG ODE VAR	
DBR	aD _b /aR	See symbol		/DYNA	/(86)	ALA ALA ALA ALB AL9 APPLY STATEF TH3	I 08R 1 08R 1 08R I 08R 1 08R 1 08R I 08R I 08R I 08R
DBRR	a ² D _b /aR ²	See symbol	,	/DYNA	/(87)	AL9 AL6 AL7 AL8 AL9 APPLY STATEF TH3	DBAA I DBAR I DBAR I DBAR I DBAR I DBAR I DBAR I DBAR I DBAR
GAMMAD		Pitch rate	(RAD/SEC)	/DYNA	/(68)	ARCIN CONTRL	I GAMMAI D GAMMAI I GAMMAI I GAMMAI
AE	A _{exit}	Total mozzle emit area	(FT ²)	/DYNA	/(89)	ARCIN IMPULS NLDRY	1 AE D AE 1 AE 1 AE 1 AE
TAX W	u	Not used. Weight	(LBS)	/DYNA /DYNA	/(90) 91)	ENVPRO OUTPUT PDBCQL OLTOSZ STATEF	
SINPHI	sin∲	See symbol		/DYNA	/(92)	ALT	
COSPHI	cos∲	See symbol		/DYNA	/(93)	AL4 APPLY	I COSPHI I COSPHI I COSPHI O COSPHI M COSPHI I COSPHI
SINPSI	sin∳	See symbol .		/DYNA	/(94)	AL7 AL8 AL9 CONTRL	I SIMPS I SIMPS
COSPSI	cos∜	See symbol		/DYNA	/(95)	AL4 AL7 AL8 AL9 CONTRL	I COSPS:

SYMBOL	MATH Symbol	DESCRIPTION	BLOCK	ORAG	LOC	SUBR C	006	US A
SINRHO	sinp	See symbol	/DYNA	/(96)	NLDRY	I I I I I I	SINA SINA SINA SINA SINA SINA SINA SINA
COSRHO	C 0 8 ρ	See symbol .	/DYNA	/(97)	ALT AL8 AL9 CONTRL NLDRY	1 1 1 1 1	COSE COSE COSE COSE COSE COSE COSE COSE
SINROR		Not used.	/DYMA	/(98)			
COSROR		Not used.	/DYNA	/(99)			
MUR		Not used.	/DYNA	/(100)			
xke	k,	Algebraic equation used in vertical rise and pitchover	/DYNA	/(101)	CONTRL	M	XK 6
XKP	k _≠	Algebraic equation used in vertical rise and pitchover	/DYNA	/(102)	CONTRL		XKP
AKIN	_	Not used.	/DYNA	/(103)			
CD0	CDO	Drag coefficient at a = 0	/DYNA	/(STATEF	I	CD0 CB0
CDOM	96 ⁰⁰ 36	See symbol	/DYNA	/(STATEF	I	CDO
CLO	c ^{ro}	Lift coefficient at a = 0	/DYNA	/(STATEF	1	CFO
FK	k	Induced drag coefficient	/DYNA	/(STATEF	1	FK FK
XCGM	ax _{ce} /am	See symbol	/DYNA	/(108)	STATEF	Ħ	XCE XCE XCE
XCGMM	92X _{CG} /9#2	See symbol	/DYNA	/(109)	STATEF	À	XCE XCE
ZCGM	91 ^{C6} /9#	See symbol	/DYNA	/(110)	STATEF	M	ZC6 ZC6
ZCGMM	a²Z _{cG} /a∎²	See symbol .	/DYNA	/(111)	STATEF	M	ZC6 ZC6 ZC6
XJA	aj/av	See symbol	/DYNA	/(112)	DL2 STATEF	I O	XIA XIA
RLX	aj/aR	See symbol	/DYNA	/(113)	DL2 STATEF	1	XJR XJR XJR
XJVV	a ² j/av ²	See symbol	/DYNA	/(114)	DL2 STATEF	1 0	XIA XIA XIA
XJVR	a²j∕avaR	See symbol	/DYNA	/(115)	DL2 STATEF	I O	Y LX
RALK	a²j/aR²	See symbol	/DYNA	/(116)	DL2 STATEF	I O	XJR XJR
						UT	1	XJR

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FORTRAN	MATH Symbol	DESCRIPTION	510	STORAGE BLOCK LOC			SUBROUTINE SUBA CODE		
SYMBOL	ZAMBUL	DEGUNTI PTON	BLUCK		100	208# C	.001	VAR	
MACHRR	∂ ² m/∂R ²	See symbol	/DYNA	/(118)	STATEF	A I	MACHRR MACHRR	
SINZRO	sin2p	See symbol	/DYNA	/(119)	AL7 ALB	I I I I	SIN2RO SIN2RO SIN2RO SIN2RO SIN2RO	
COSZRO	cos2p	See symbol	/0YMA	70	120)	AL7 AL8	I I I I 0	COSZRO COSZRO COSZRO COSZRO COSZRO	
COS2GM	cos27	See symbol	/DYNA	/(121)	AL4 STATEF	1	COS264	
CR	c*	Moment coefficient	/BYNA	/(122)	MOME CO UT	0	CM CM	
CMA	. C.	Moment coefficient slape (RAD-)	/DYNA	/(123)	MOMECO STATEF UT	I M I	CMA CMA	
CRM	9C_/9M	See symbol	/DYNA	/(124)	MDMECD UT	0 I	CMA	
CMAA	∂C _{#a} /∂a	See symbol	/DYMA	/(125)	MOME CO UT	0 1	CMAA CMAA	
CMMM	920 , /9 m 2	See symbol	/BYNA	/(126)	MOMECO	0	CMMM	
CMAM	90 , _/am	See symbol	/OYNA	/(127)		I M I	CMAR CMAR CMAR	
CMO	C.	Moment coefficient at a = 0.	/DYNA	/(128)	MOMECO Statef	1 1	CM0	
CHOM -	aC0/aM	See symbol	/DY#A	11	129)	MOMECO STATEF		CMOM	
CHOM	a ² C ₌₀ /am²	See symbol .	/DYNA	/([']	130)	MOMECO Statef	I I	CMOMM CMOMM	
CMAMM	92C / 3M2	See symbol	/DYNA	/(131)	MOMECO STATEF		CMARM CMARM	
ULFTY	9F"\9A	See symbol	/BYNA	/(132)	AL3 UT	I	ULFTV	
ULFTR	aL _# /aR	See symbol	/DYNA	/(133)	AL3 UT	I M	ULFTR ULFTR	
ULFTYY	9 ² L ₄ /9V ²	See symbol	/DYMA	/(134)	AL3 UT	I	ULFTYY	
ULFTVR	∂ ² L_/∂V∂R	See symbol	/DYNA	/(135)	AL3 UT	I	ULFT VR	
ULFTVA	∂ ² L_/∂V∂∝	See symbol	/DYNA	,((1361	AL3 UT	l	ULFTVA	
ULFTRA	∂ ² L ₄ /∂R ²	See symbol .	/DYNA	/(137)	AL3 UT	i	ULFTRR	
ULFTRA	∂ ² L ₄ /∂R∂α	See symbol .	/DYNA	/(138)	AL3 UT	ī	ULFTRA ULFTRA	
IPO#		Powered fing. IPOM = 0: No thrust and no base drag IPOM = 1: Thrust, but no base drag IPOM = 2: Thrust and base drag	/DY NA	/(139)	ARCIN FORCES NPLANE STATEF THROTL	M I I I I	IPOW IPOW IPOW IPOW	
XARC		Quasitine at shich present subsrc commenced.	/DYNA	/(140)	ARCIN Statef	0 I	XARC XARC	
TSTART		Trajectory time at which present subarc commenced.	/BYNA	/(141)	ARCIN	M M I O	TSTART TSTART TSTART TSTART	

FORTRAN	MATH Symbol	DESCRIPTION	STORAGE			SUBROUTINE L		
SYMBOL	SAMBOL	DESCRIPTION	BLOCK		LOC	208K	CODE	PAV
бн	ag/aR	See symbol .	/DYMA	/(142)	AL7 AL8 NLDRV Statef	i I I	ен ен ен
GRR	a²g/aR²	See symbol	/DYNA	/(143)	AL7 AL8 NLDRV STATEF	1 1 1	GRR GRR GRR GRR
LIFTAA	∂ ² L/∂α ²	See symbol	/DYNA	/(144)	AL1 AL4 AL5 AL6 APPLY TH3 UT	1 1	LIFTAN LIFTAN LIFTAN LIFTAN LIFTAN LIFTAN
CDGMM	∂ ² C _{D0} /∂M²	See symbol	/DYNA	/(145)	AEROCO Statef		MMOD3
CLAMM	a ² C _{L_a/am²}	See symbol	/DYNA	/(AEROCO Statef	M	CLAMM
CLOM	ac _{Lo} /am	See symbol	/DYNA			STATEF	1	CLOM
CLOMM	∂ ² C _{L0} /∂M ²	See symbol	/DYNA	70		AEROCO Statef		CLOMM
DYN149		Not used.	/BYNA	/(149)			
CT	c _T	Value for thrust in case constant thrust constraint is used. (LBS)	/DYNA	/(150)	THI	I	CT
CODAE	c σ s (α - s _E)	See symbol	/BYNA	/(151)	AL1 AL4 AL6 AL7 AL8 AL9 APPLY CONTRL NLDRV TH3 UT	I I I I I I I I I	CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE
SIDAE	sin(α-6 _E)	See symbol	/DYNA	/(152)	AL1 AL4 AL6 AL7 AL8 AL9 APPLY CONTRL TH3	I I I I I I I I	SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE
COD	coss _E	See symbol	/DYNA `	/(153)	DL2 DUTPUT TH3 UT	1 1 1	COB COB COD COD
SID	sins _E	See symbol	/DYNA	/(154)		I I I	SID SID SID SID
DELTAE	* E	Engine deflection (RADS)	/DYNA	/(155)	ALGCON	M M I I	DELTAE DELTAE DELTAE DELTAE DELTAE DELTAE
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FORTRAN Symbol	MATH Symbol	DESCRIPTION		BLOCE	ORAG (£ L0€	SUBROUT SUBR	114 COD	E USAGE
xce	Х _С	Center of gravity body x station	(FT)	/DYNA	/(157)		I 1 1	XC6 XC6
zce	Zce	Center of gravity body z station	(FT)	/DYNA	/(158)	DL2]]]	ICG ICG
XJ	j	Control blend factor		/DYNA	10	159)	ARCIN DL2 OUTPUT	0	x) x) x) x)
XMCG	M _{CG}	Aerodynamic moment about center of gravity ((FT-LBS)	/DYNA	/(160)	DL2 DUTPUT UT	I I	IMC6 IMC6 IMC6
CALPHA	c *	Value for angle of attack in case constant ang attack constraint is used.	(RADS)	/DYNA	/(161)	ALZ NPLANE	î M	CALPHA Calpha
ALMAX	α mex	Magnitude of angle of attack constarint	(RADS)	/DYNA	/(162)	ARCIH NPLANE	0 1	ALMAX ALMAX
DB	D _b	Base drag	(LB\$)	/DYNA	/(163)	AL1 AL4 AL6 AL7 AL9 AL9 CONTRL NLDRY CUTPUT STATEF TATEF TATEF UT	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	08 08 08 08 08 08 08 08 08 08
ULFT	L	Untrimmed merodynamic lift	(LBS)	/OYNA	/(164)	AL3 NPLANE UT	I I	ULFT ULFT
CULFT	CL"	Magnitude of untrimmed lift limit	(LBS)	/DYNA	/(165)	AL3 NPLANE	0	CULFT
ULFTA	∂L _u /∂¤	See symbol		/DYNA	/(166)	AL3 UT	I	ULFTA ULFTA
TSTAGE		Trajectory time at which present rocket engine ignited.	(SECS)	/DYNA	/(167)	ARCIN STATEF TRAJIN	I O	TSTAGE TSTAGE TSTAGE
TIMES		Elapsed burning time of present rocket engine	(SECS)	/DYNA	/(168)	STATEF	M	TIMES
XMCGAA	∂ ² M _{CG} /∂¢ ²	See symbol		/DYNA	/(169)	DL2 UT	I	XMCGAA XMCGAA
IRATED		1% of the maximum rated I _{SP}	(SECS)	/DYNA	/(170)	ARCIN IMPULS	0	IRATED IRATED
FRATED		1% of the maximum rocket vacuum thrust	(LBS)	/DYNA	/(171)	ARCIN IMPULS	0 I	FRATED FRATED
MTT		Table number for tabulated rocket vacuum thrus	t	/DYNA	/(172)	ARCIN STATEF	M	ATT ATT
11		Thrust option flag. J1 = 1: Constant thrust; J1 = 2: Input vacuum thrust; J1 = 3: Powered total acceleration limit; J1 = 4: Air-breather engine.		/DYNA	/(173)	APPLY ARCIN CONTRL FORCES NPLANE STATEF THROTL	1 0 M I I	J1 J1 J1 J1 J1 J1
J2		Engine deflection option flag. J2 = 1: Constant engine deflection; J2 = 2: Moment balancing.		/DYNA	/(174)	ARCIN CONTRL NPLANE		J2 J2 J2

13		Angle of attack option flag. J3 = 1: Options angle of attack; J3 = 2: Constant angle of attack; J3 = 3: Untrinued lift limit; J3 = 4: Vertical rise or pitchover; J3 = 5: Unpowered total acceleration limit J3 = 6: Gravity turm; J3 = 7: Dynamic pressure constraint; J3 = 8: Heating rate constraint; J3 = 9: Reynolds number constraint.	; ,	/DYNA	/(175)	ARCIN CONTRL NPLANE OUTPUT	Ħ	13 13 13
XMCGA	∂M _{CG} /∂α	See symbol		/DYNA	/(176)	DL2 UT	I	XMCGA
FVACE		Not used.		/DYMA	/(177)			
ULFTAA	∂ ² L ₄ /∂α ²	See symbol		/DYNA	/(178)	AL3 UT	I	ULFTAA
ISPF	1 _{SP} /aT	See symbol		/DYNA	/(179)	APPLY IMPULS	I	ISPF ISPF
ISPFF	921 _{SP} /912	See symbol		/DYNA	/(180)	APPLY IMPULS	I	ISPFF ISPFF
ILOAD		Logical flag that is true if there is any aerod load on the vehicle.	ynamic	/DYNA	/(181)	ARCIN CONTRL NPLANE UT		ILOAD ILOAD ILOAD ILOAD
FKM	9k/9M	See symbol		/DYNA	/(182)	AEROCO Statef		FKM FKM
FKMM	a²k/am²	See symbol		/DYNA	/(183)	AEROCO Statef		FKMM FKMM
SWITCH		Logical flug that is true if this is the comput at shich the powered acceleration constraint commences.	e point	/DYNA	/(184)	CONTRL NPLANE THROTL	I	SWITCH SWITCH SWITCH
INGF		State variable inequality constraint flag. INQF = 0: No SVIC in effect; INQF = 7: Dynamic pressure IC in effect; INQF = 8: Heating rate SVIC in effect; INQF = 9: Reynolds number SVIC in effect.		/DYNA	/(185)	ARCIN NPLANE		I NOF I NOF
CL	c _L	Lift coefficient ,		/DYNA	/(186)	AEROCO OUTPUT UT		Cr Cr
CLA	c _{L*}	Lift coefficient slope	(RAD ⁻¹)	/DYNA	/(187)	AEROCO STATEF UT		CLA CLA
CLM	ac _L /am	See symbol		/DYNA	/(188)	AEROCO UT	M 1	CLM
CLAA	9C _L /9a	See symbol		/DYNA	/(189)	AEROCO UT	Ħ	CLAA
CLMM	a²C _L ∕am²	See symbol .		/DYNA	/(190)	AEROCO UT	M I	CLMM CLMM
CLAM	ac _{L.} /am	See symbol		/DYNA	/(191)	AEROCO STATEF UT		CLAM CLAM CLAM
CD	co	Drag coefficient		/DYNA	/(192)	AEROCO OUTPUT UT		CD CD
CDA	•			/DUMA				_	

DESCRIPTION

STORAGE SUBROUTINE USAGE BLOCK LOC SUBR CODE VAR

CBA CBA CDM

CDAA CDAA

CDAR

194) AEROCO O UT I

195) AEROCO M UT I

/DYNA /(196) AEROCO O UT I

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CDA

COM

CDAA

COMM

 $\mathfrak{c}_{D_{\bullet}}$

aC_D/am

9C_{D°}/9¢

∂²C_D/∂M²

FORTRAN SYMBOL

MATH SYMBOL

Ecific fuel consumption of airbreather

FORTRAN Symbol	MATH Symbol	DESCRIPTION	BLOC	ORAG	LOC	SUBROU SUBR	COD	E USAGE
3111000			0200			300	-	
CDAM	aC _D _/am	See symbol	/DYNA	/(197)	AEROCO UT	A I	CDAM
DYN198		Not used.	/DYNA	/(198)			
DYN199		Not used.	/DYNA	/(199)			
DAMSOO		Not used.	/DYNA	/(200)			
XMCGV	aM _{CG} ∕av	See symbol .	/OYNA	/(201)	OL2 UT	I M	XWCGA
XMCGR	∂M _{CG} /∂R	See symbol	AMYG\	/(202)	DL2 UT	I M	XMC GR XMC GR
XMCGM	∂M _{CG} /∂m	See symbol	/DYNA	/(203)	BL2 UT	Ĭ	XMCGM XMCGM
XMCGVV	∂ ² M _{CG} /∂V ²	See symbol	/DYNA	/(204)	DL2 UT	I,	XWC BAA XWC BAA
XMCGVR	a²M _{CG} ∕avaR	See symbol	/DYNA	/(205)	DL2 UT	I	XMCGVR XMCGVR
XMCGVM	a ² M _{CG} /ava•	See symbol	/DYNA	/(·206)	UT	I	XWCGAW
XMCGVA	∂ ² M _{CG} /∂V∂α	See symbol	/DYNA	/(207)	DL2 UT	ĭ	XMCGVA
XMCGRR	∂ ² M _{CG} /∂α ²	See symbol	/DYNA	/(208)	DL2 UT	I	XMCGRR XMCGRR
XMCGRM	∂ ² M _{CG} /∂R∂m	See symbol	/DYNA	/(209)	DL2 UT	ĭ	XMC GRM XMC GRM
XMCGRA	a ² M _{CG} /aRaa	See symbol	/DYNA	/(210)	DL2 UT	I	XMCGRA XMCGRA
XMCGMM	∂ ² M _{CG} /∂m ²	See symbol .	/DYNA	/(211)	DL2 UT	I	XMCGMM
XMCGMA	a ² M _{CG} /amaa	See symbol	/DYNA	, ,(212)	DL2 UT	I	XMCGMA
RORRR	$\partial^3 \rho_a^2 / \partial R^3$	See symbol	/DYNA	/(213)	AL7 AL8 AL9 Statef	I I I	RORAR RORAR RORAR BORAR
DYN214	μ_{\bullet}	Atmospheric viscosity (dynamic) (SLGS/FT/SEC)	/DYNA	/(214)	OUTPUT PDBCQL		AMR -
DYN215	∂μ _∎ /∂R	See symbol	/DYNA	/(215)	POSCOL	I	YMR
DYN216	$\partial^2 \mu_a / \partial R^2$	See symbol	/DYNA	/(216)			
DYN217	$\partial^3\mu_{\rm e}/\partial R^3$	See symbol	/DYNA	/(217)			, ,
IDAM		Optional atmospheric calculations flag. IDAM = -1: Compute ∂ ³ ρ _g /∂R ³ ; IDAM = 0: No optional calculations; IDAM = 1: Compute ∂ ³ ρ _g /∂R ³ , μ _g , ∂μ _g /∂R, etc.	/DYNA	/(218)	ARCIN ERROR NPLANE STATEF WRAPUP	M	IDAM IDAM IDAM IDAM IDAM
TAIRB		Air-breather engine thrust (LBS)	/DYNA	/(219)	STATEF TH4	I	TAIRB TAIRB
TAIRBV	•	Partial of TAIRB prt V	/DYNA	/(220)	THA	I	TAIRBY
TAIRBH		Partial of TAIRB wrt h (altitude)	/DYNA	/(221)		I	TAIRBH
TARBVV		Second partial of TAIRB wrt V	/DYNA	/(222)		I	TARBYY
TARBHH		Second partial of TAIRB art h	/DYNA	11	223)		1	TARBHH
TARBVH		Second partial of TAIRB ort V and b	/DYMA	/(224)		I	TARBYN
SFC			/DYNA	/(225)	APPLY	i	SFC
		Partial of SFC ort V	/DYNA	/(226)	APPLY	I	SFCV
SFCV								
SECH		Partial of SFC wrt h	/DYNA	/(227)	APPLY	I	SFCM

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FORTRAN Symbol	MATH Symbol	DESCRIPTION	STO BLOCK	PAC	.e LOC	SUBROL SUBR	COD	E USAGE E VAR
SFCHH		Second partial of SFC wrt b	/DYNA	/(229)	APPLY	1	SFCHŅ
SFCVH		Second partial of SFC ort V and h	/DYNA	/(230)	APPLY	1	SECVH

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BLØCK EVAL

FORTRAN	MATH	DESCRIPTION		RAGE			USAGE
SYMBOL	SYMBOL	DESCRIPTION	BLOCK	LOC	SUBR	CODE	VAR
SGN		Sign of the variable SIG in the 65th word of common block /GOBAL/. SGM = +: payoff to be maximized; SGM = -: payoff to be minimized.	/EVAL	/(1)	BNDRY ENDPT	0 1	S GM S GM
SPART		An 18 word array whose first nine entries receive the values of the partial derivatives wrt the state of those target conditions computed in subroutine PDBCQL.	/EVAL	/(2)	BNDRY BRANPT ENDPT INTRPT	Ī	SPART SPART SPART SPART
MAP		A 10 mord array that maps the steepest descent state vector into the QL state vector.	/EVAL	/(20)	BNDRY BRANPT ENDPT INTRPT	I	MAP MAP MAP
PZI		A 40 mord array that contains the target condition misses for all the target conditions in the problem.	/EVAL	/(30)	BNDRY BRANPT ENDPT INTRPT	Ä	PZI PZI PZI PZI
NOCK	· I	The number of c's in the vector $\textbf{C}_{\underline{I}}$ defined by Equation 17.4-9 of Vol.1 of this document.	/EVAL	/(70)	BNORY BRANPT ENDPT INTRPT	I	NOCK NOCK NOCK
S		An 18x41 array used to store the particular and homogeneous solutions on the early side of a corner point.	/EVAL	/(71)	BNDRY BRANPT ENDPT INTRPT	1	\$ \$ \$ \$
TEMP	(94 ¹ /9C ¹) _⊥	A 40 mord array that contains the transpose of the vector defined by Equation 17.4-9 of Vol.I of this document.	/EVAL	/(809)	BRANPT ENDPT INTRPT	Ī	TEMP TEMP TEMP
DZ	$\Delta e_{i}h_{i}(I_{-})$	An 18 word array that contains the second term on the right hand side of Equation 17.4-11 of Vol.1 of this document.	/EVAL	/(849)	BRAMPT ENDPT INTRPT	Ī	DZ DZ OZ
DC	Δci	Small perturbation of a c.	/EVAL	/(867)	BNDRY BRAMPT ENDPT INTRPT	I	DC DC DC
L		Total number of target conditions to satisfy in the problem.	/EVAL	/(868)	BNDRY BRAMPT ENDPT INTRPT	M	L L L
\$1		An 18x41 array used to store the particular and homogeneous solutions on the late side of a corner point.	/EVAL	/(869)	BRANPT INTRPT		\$ I \$ I

BLØCK F

FORTRAN SYMBOL	MATH Symbol	DESCRIPTION	S BLO	TORAL	LOC		E USAGE E VAR
F		An 820x4 array used to store the vectors \mathbf{x}_1 , \mathbf{x}_2 , \mathbf{x}_3 , and \mathbf{x}_4 defined by Equations 17.6.7 thru =10 of Vol.1 of this document.	/F	/(1)	MADAMS SALVE	



BLØCK GLØBAL

FORTRAN	MATH	DESCRIPTION		STORA			INE USAG
ZYMBOL	SYMBOL	DESCUTATION		BLOCK	LOC	SUBR C	DDE VAR
GR	9 ₁ -	Gravitational acceleration at surface of the ear (F)	th. /SEC ²)	/GLOBAL/(1)	ALF APPLY BRANPT COSTAB COSTAI INTRPT DUTPUT PUBCQL QLTOSI SALVE SALVE THIS	GR
ER	E _R	Earth radius.	(FT)	/GLOBAL/(2)	ENVPRO PDBCQL DLTQSZ STATEF	E ER
OMEZ		Earth rotation rate (RF	D/SEC)	/GLOBAL/(3)	PDBCQL TRAJIN	
XLAMRF	ρ_{r}	Reference latitude.	(DEG)	/GLOBAL/(4)	CHECK	I XLAMR
YMURF	μ_r	Reference longitude.	(DEG)	/GLOBAL/(5)	CHECK	. YMURF
LUM		Program control flag. LUM = 0: Steepast descent only; LUM = 1: Steepest descent and edjoint transformation stored on tape; LUM = 2: Steepest descent and QL; LUM = 3: QL only.		/GLOBAL/(6)		-
Τ0	^t o	Trajectory start time.	(SEC)	/GLOBAL/(7)	FETCH INARC TRAJIN WRAPUP	TO TO
EPSLON	€	QL iteration convergence criterion.		/GLOBAL/(8)		M EPSLO
INNER		Number of Adams-Moulton inner loops.		/GLOBAL/(9)	CHECK MADAMS	A INNER
1 TRMAX		Maximum number of QL iterations.		/GLOBAL/(10)	CHECK GROPE	M ITRMA
JJOP		A six mord array used for various internal flags		/GLOBAL/(11)		
IFATAL		Fatal error flag.		/GLOBAL/(17)	ERROR) IFATA
NARC	N ₃	Number of subarcs in the problem.		/GLOBAL/(18)	ENVPRO FETCH I NARC	I MARC I MARC I MARC I MARC I MARC I MARC I MARC I MARC I MARC
NBRAN	N ₁	Number of the last subarc on the stem of a branc problem. If the problem is not a branch problem MBRAN = 0.		/GLOBAL/(19)	BNDRY BRAMPT COSTAB ENVPRO INTRPT MAGIC OLTOSZ SALVE	I MBRAN I MBRAN I MBRAN I MBRAN I MBRAN I MBRAN

FORTRAN Symbol	MATH Symbol	DESCRIPTION	STORAL BLOCK	LOC	SUBROUTIN	
NFARC	N ₂	Number of the last subarc on the first branch. If the problem is not a branch problem, then NFARC = MARC.	/GLOBAL/(20)	BCOND I BNORY I BRANPT I COSTAB I ENVPRQ I INTRPT I MAGIC I QLOSZ I	NFARC NFARC NFARC NFARC NFARC NFARC NFARC
10		A four word array containing the basic deck, reference run, case and part case numbers in that order.	/GLOBAL/(21)		
KTAB		A 20 word array containing the number of state target conditions specified at the end of each subarc.	/GLOBAL/(25)	BCONB I	KTAB
ITAB		A 20 word array containing the number of nonzero state initial conditions specified at the beginning of each suborc.	/GLOBAL/(45)	BCOMB I	ITAB
\$1 6		Payoff sign. SIG < 0: Payoff to be minimized; SIG > 0: Payoff to be maximized.	/GLOBAL/(65)	BNDRY I	516
MAXTAB		Largest univariant table number in this case.	/GLOBAL/(66)	SPLINE I	MT
6 m	GM	Product of Newton's universal gravitational constant and the wass of the earth. (FT ³ /SEC ²)	/GLOBAL/(67)	OUTPUT I PDBCQL I STATEF I	6# 6# 6#
PSIRF	≠ _r	Reference azimuth. (DEG)	/GLOBAL/(68)	CHECK I	PSIRF
IPFLG1		IPFLG1#0 supresses print-out of velocity losses and inertial Euler angles.	/GLOBAL/(69)	OUTPUT I POBCOL I QLTOSZ O SALVE I	IPFLG1 IPFLG1 IPFLG1 IPFLG1
IPFLG2		IPFL62≠0 supresses print-out of orbital parameters.	/GLOBAL/(76)	OLTOSZ O	IPFLG2
1PFL63		IPFLG3≠0 supresses primt-out of impact data.	/GLOBAL/(71)	OUTPUT I	IPFLG3 IPFLG3
IPFL64		IPFL64#0 supresses print-out of inertial Cartesian coordinates.	/GLOBAL/(72)	•	
INEGFL		A 20 mord array that contains the code number of the state variables inequality constraint that applies on each subarc. A zero entry indicates that no SVIC applies.	/GLOBAL/(73)	ARCIN 1	INEOFL
1TPSO		A non zero input value indicates to the steepest descent module that the initial steering angle profiles are stored on logical unit 11.	/GLOBAL/(93)		
KSOL		An internal flag that has the same significance as ITPSO.	/GLOBAL/(94)		
INARK		Logical unit on which initial and converged arcs are stored. INARK = 11.	/GLOBAL/(95)	CHECK OFETCH I INARC- I MARCH I WRAPUP I	I MARK I WARK I MARK I MARK I MARK
KELOBL		A seven word array not used.	/GLOBAL/(96)	ERROR O	KGLOBL



BLØCK JACØB



ORTRAN Symbol	MATH SYMBOL	DESCRIPT ION	BLOCK	LOC	<u> </u>	CODE	USAG
							
JAKE		An $18x18$ array defined by Equation 17.5-5 in Vol.1 of this document. The entry in the 1-th row and 1-th column is the total partial derivative of the quasitime derivative of the Y_1 component of Y with	/JACOB /	1)	LINDRY NLORY NLORY SALVE	Ħ	JWKE ADA JWCOB JWKE
		respect to the Y; component of Y, i.e., aYi/aYj, where					
edv		Y ^T = (y ^T , λ ^T) Gescription not input	/ 8634[/		M1 60 H	n	60A
PDV		Description not imput	/JACOB /		MFDBA		PDV
ADV		Description not input	/JACOB /		NLDRY		RBV
004		Description not Input	/JACOB /4		MEDRA		ODV
UDV	•	Description not imput	/JACOB /(MLDRY		UDV
MDV		Description not input	/JACOB /(NLDRY		MBY
HTDV		Description not input	/JACOB /		NLDRY		HTBV
TADA na		Description not imput	/JACOB /		MEDRA		FADA
LGDV		Description not imput	/JACOB /(NLDRY		FADA
LPDV		Description not input	/JACOB /(MLDRY		LPDV
LRDV		Description not input	/JACOB /(MLDRY	-	LROV
LODY		Description not input					
		·	/JACOB /(NLORY	-	FODA
LMDV		Description not input	/JACOB /(NLDRY		LWDY
LTDV		Description not input	/JACOB /(MLDRY		LTDV
AD6		Description not input	/JACOB /(NLDAY		ADE
606		Description not imput	/JACOB /(MFDRA		6D6
PDG DDG		Description not input	/JACOB /		NLDRY		PDG
RDG		Description not input	/JACOB /		NLDRY		R06
006		Description not input	/JACOB /(NLORV		0D6
UDG		Description not input	/JACOB /		MLDRY		900
MD6		Description not input	/JACOB /		NLDRY		MD6
L V 0 6		Description not input	/JACOB /		NLDRV		FA06
F 606		Description not input	/JACOB /		NLDRY		LED6
LPDG		Description not input	/JACOB /		NLDRY	-	LPD6
LRDG		Description not input	/JACOB /		NLDRY		LRDS
LOD6		Description not imput	/JACOB /		NLDRY		F0D6
LMDG		Description not input	/JACOB /		NLDRV		LMDG
LTDG		Description not input	/JACOB /		MFDBA	-	LTDS
VDP		Description not input	/JACOB /		NLDRY		VOP
60P		Description not input	/JACOB /		NLDRY		CDP
PDP		Description not input	/JACOB /		HLDRY		PDP
O DP		Description not input	/JACOB /		NLORY		ODP
UDP		Description not input	/JACOB /		NLBRY		UDP
MDP		Description not input	/JACOB /		NLDRY	•	RDP
LVDP		Description not input	/JACOB /		NLDRY		LVDP
LGDP		Description not input	/JACOB /		NLDRY		LGDP
LPDP		Description not input	/JACOB /	48)	NLDRV	M	LPOP
LROP		Description not input	/JACOB /		NLDRY		LRDP
LOOP		Description not input	/JACOB /	50)	NLBRY	0	LODP
LIDP		Description not imput	/JACOB /	53)	NLDRY		LTOP
VOR		Description not imput	/JACOB /	55)	NLDRV	M	VDR -

C)	
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FORTRAN SYMBOL	MATH Symbol		DESCRIPTION	STO BLOCK	RAG	LOC	<u>Subrol</u> Subr	COD	E USAGE E VAR
POR		Description not	input	/JACOB	<i>10</i> ·	57)	MLDRY	m	PDR
ODA		Description not	•	/JACOB	/(59)	MLDRY	79	ODR
UDR		Description not	•	/JACOB			MLDRV	Ħ	UDR
MDR		Description not	•	/JACOB	/(61)	NLDRY	Ħ	MDR
HTDR		Description not	Input	/JACOB	/(NLDRY	m	HTDR
LVDR		Description not	input	/JACOB	/(64)	NLDRY	Ħ	LVDR
LGDR		Description not		/JACOB	/(65)	MLDRY	H	LGDR
LPDR		Description mot	input	/JACOB	/(66)	MLDRY	M	LPDR
LRDR		Description not	Input	/JACOB	/(67)	MLDRY	Ħ	LRDR
LODR	_	Description not	Input	/JACOB	/(68)	MLDRY	0	LODA
LMOR		Description not	input	/JACOB	/(70)	NLOR V	0	LMDR
LTDR		Description not	Input	/JACOB	/(71)	NLDRY	0	LTDR
VD0		Description not	input	/Jecob	/(73)	MLORY	Ħ	VDO
600		Description not	Imput	/JACOB	/(74)	WLDRY	Ħ	600
P 00		Description not	input	/JACOB	/(75)	MLDAV	Ħ	PDO
UD0		Description not	Imput	/JACOB	/(78)	MLDRA	M	UDO
MDO		Description not	input	/JACOB	/(79)	MLDRY	M	MDD
FAD0		Description not	input	/JACOB	/(82)	MLDRY	Ħ	LVDO
r edo		Bescription not	input	/JACOB	/(83)	MLDRV	Ħ	LGDO
LP00		Description not	Input	/JACOB	/(84)	NLDRV	Ħ	LPDO
LRD0		Description not	Input	/JACOB	/(85)	NLDRY	Ħ	LRDO
L000		Description not	input -	/JACOB	/(86)	MLDRY	M	LODO
LT 00		Description not	input	/JACOB	/(89)	NLDRY	0	LTDO
ADM 🛒		Description not		/JACOB	/(109)	NLDRY	M	VDM
SDR		Description not	input	/JACOB	/(110)	MLDRY	Ħ	GDM
PDR		Description not	input	/JACOB	/(111)	MLDRV	M	PDM
NDH,		Description not	•	/JACOB	/(115)	MLDRY	M	MDM
FADM		Description not	input	/JACOB	/(118)	MFDRA	0	LVDM
LGDM		Description not	•	/JAC0B		119)	MEDUA	0	LGDM
LPDM		Description not	-	/JACOB			MLDRY	Đ	LPBM
LRDM		Description not	•	/JACOB			WLDRA	0	LRDM
LODA		Description not	•	/JACOB			MLDRY	0	LODM
LADA		Description not	•	/JACOB			MLDRY	0	LMDM
LTDM		Description not	-	/JACOB			MFDRA	9	LTDM
VDT		Description not	•	/JACOB			NLDRY	M	YDT
6DT		Description not	•	/JACOB			NLDRV	M	6DT
PDT		Description not	•	/JACOB			NLDRY	M	PDT
ADT		Description not	•	/JACOB			NLDRY	19	RDT
ODT		Description not	•	/JACOB			NLDRV	M	ODT
UDT		Description not	•	/JACOB			NLDRV	M	TGU
RDT		Description not	• 1	/JACDB			NLDRV	Ħ	MOT
HTDT		Bescription not		/JACOB			NLDRV	M	HTDT
LVDT		Description not	•	/JACOB			NLDRV	M	LVDT
LGDT		Description not		/JACOB					LGDT
LPOT		Description not		/JACOB					
LADT		Description not		/JACOB			NLDRY	M	LRDT
LODT		Description not	·	/JACOB			NLDRV		LODT
LADT		Description not	•	/JACOB			NLDRY		LMBT
LTDT		Description not	Input	/JACOB	/(143)	NLDRY	0	LTDT
10 NOV 72 G	. 01 - 47								
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GRTRAN	MATH	DESCRIPTION	STORA BLOCK	GE	SUBROUT	INE USAGE
SYMBOL	SYMBOL	DE00111111014	BLOCK	FOC	SUBH C	DDE VAR
ADFA	Bescri	ption not input	/JACOB /(163)	NLDAY	D ABFA
6DLV		ption not imput	/\ 803AL\			0 60LV
POLY		ption not input	/JACOB /(O PDLV
DLY		ption not imput	/JACOB /(O MOLV
ADFA		ption not input	/JACOB /(D FADFA
GDLV		ption not input	/JAC08 /(O FEDTA
POLV		ption not input	/JACOB /(O LPDLV
RDLV		ption not input	/JACOB /(O LRDLY
LODLY		ption not input	/JACOB /(O FODFA
LMDFA		ption not imput	/JACOB /(D FWOFA
LTOLV		ption not imput	/JACOB /(O LTDLY
10L6		ption not input	/JACOB /(0 ADFE
6016		ption not imput	/JACOB /(0 GDLG
PDLG		ption not input	/JACOB /(8 PDL6
MDL6		ption not input	/JACO8 /(O MDLG
LADER		ption not input	/JACOB /(O TADE
LGOLG		ption not input	/JACOB /(0 L60L6
LPOLG		ption net input	/\ d03AL\			O LPDLG
LADE		ption not input	/\ 803AL\			O LADER
-00L6		ption not input	/JACOB /(O LODES
MDLG		ption not input	/JACOB /(O LMDLG
TDL6		ption not input)\ 803AL\			O LTDLG
IDLP		ption not imput	/JACOB /(D VDLP
60LP		ption not input	/JACOB /(0 6DLP
DLP		ption not imput	/JACOB /(O POLP
OLP		ption not imput	/JACOB /(O MOLP
VDLP		ption not input	/JACOB /(D LVDLP
		ption not input				
.GDLP .PDLP		ption not imput ption not imput)\ 803AL\ \\ 802AL\			O LEDLP
.POLP		•	/JACOB /(O LPDLP
		ption mot imput	/JACOB /(O LRDLP
ODLP		ption not imput	/JACOB /(O LODLP
MOLP		ption not input	/JACOB /(0 LMDLP
LTDLP		ption not input	/\ACOA\(0 LTDLP
_VDLR		ption not input	/JACOB /(O LVDLR
.6DLR		ption not input	/JACOB /(0 LGDLR
TOLR		ption not input)\ 803AL\			O LTOLR
.VOL8		ption not input	/JACOB /(O FADEO
L GOLO		ption not input	/JACOB /(0 F60F0
PDL0		ption not imput	/JACOB /(O LPDLO
LADEO		ption met input	/JACOB /(O LRDLO
LTOLO		ption not input	/JACOB /(O LTOLO
.VDLU		otion not input	/JACOB /(O FADER
.60LU		ption not input	/JACOB /(O LEDLU
PDLU		ption not input	/JACDB /(
LRDLU		ption not input	/JACOB /(O LRDLU
TODFA		ption not input	/JACOB /(O LODEU
LTOLU		ption not input)\ 803AL\			O LTDLU
.VDLM .RDLM		ption not input	/JACOB /(280)	NLDRY	O FADEW
		ction not input				

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FORTRAN SYMBOL	MATH Symbol	DESCRIPTION	STORAGE SUBROUTINE U BLOCK LOC SUBR CODE						
LADLA		Description not input	/JACOB /(286)	NLDRV	0	LMDLM		
LTOLM		Description not input	/JACOB /(287)	NLDRY	0	LTOLM		
LVDLH		Description not imput	/JACOB /(316)	NLDRY	0	LADEN		
LROLH		Description not input	/JACOB /(319)	NLDAV	0	LRDLH		
LTDLH		Description not imput	/JACOB /(323)	MLORY	0	LTDLM		



BLØCK LASTAB

FORTRAN SYMBOL DESCRIPTION

STORAGE SUBROUTINE USAGE BLOCK LOC SUBR CODE VAR

LASTAB

Description not input

//ASTAB/(1) TIMFO I LASTAB

(y)

BLØCK MAP

FORTRAN Symbol	MATH Symbol	DESCRIPTION	S T BLOCK	DRAGE LOC	<u>SUBAD</u> SUBA	COD	USAGE VAR
MAP		An array that maps the initial arc state and costate	/MAP	/C 1	CHECK	0	MAP

BLØCK MATS

FORTRAN Symbol	MATH Symbol	DESCRIPTION	<u> </u>	ORA(LOC	SUBROU SUBR	TINE	USAG
P1		First entry of 3 word in-plane control vector w	/MATS	/(1)	ALGCON ALGCON		P P1
P2		Description not imput	/MATS	/(2)	ALGCOM	M	PZ
P3		Description not input	/MATS	/(3)	ALGCON	Ħ	P3
XK1		First entry of 3 word in-plane control constraints K	/MATS	71	4)	ALGCON THROTL TH1 TH2 TH3 TH4	I 0 0	XK1 XK1 XK1 XK1 XK1
XK2		Description not input	/MATS	70	5)	DL1 DL2	0	XK2 XK2
XK3		Description not imput	/MATS	/(61	AL1 AL2 AL3 AL4 AL5 AL6 AL7 AL8 MPLANE OUTPUT	000000000000000000000000000000000000000	HK3 HK3 HK3 HK3 HK3 HK3 HK3 KK3
XKIT	K_{CL}^{T}	First entry of 3x3 matrix containing the explicit partials of K with respect to \mathbf{w}_{r} $\mathbf{K}_{\mathbf{w}}$	/MATS	/(7)	ALGCON TH1 TH2 TH3	0	XK1T XK1T XK1T
XK2T		Description not input.	/MATS	/(8)	ALGCON DL2		XK2T XK2T
XK3T		Description not input	/MATS	/(9)	ALGCON ALI AL4 AL6 AL7 AL8 AL9	0 0 0	XK3T XK3T XK3T XK3T XK3T XK3T
XKID		Description not input	/MATS	/(10)	ALGCOM TH3		XK1D XK10
XK2D		Description met imput	/MATS	'n	11)	ALGCO# AL1 DL1 DL2	1	XK2D XK2D XK2D XK2D
XK3D		Description not imput	/MATS	/(12)	ALGCOM AL1 AL4 AL6 AL7 AL8 AL9	1 0 0 0 0	XK3D XK3D XK3D XK3D XK3D XK3D
XKIA		Description not imput	/MATS	/(13)	ALGCON TH3	I	XKIA XKIA
XK2A		Description not input	/MATS	76	14)	ALGCOM AL1 DL2	I	XK2A XK2A XK2A
XK3A		Description not input	/MATS	/(15)	ALGCON AL1 AL2 AL3 AL4 AL5 AL6 AL7 ALB AL9	00008000	X 3 A X 3 A X 4 3 A X 4 3 A X 4 3 A X 5 A X 5 A X 6 3 A X 7 A X 8 3 A X 8
VDA	κ ^{γ*} (3)	Explicit partial of $K^{(3)}$ art λ_{ϕ} when ϕ is optimal.	/MATS	73	16)	ALSCOM AL1	I	VDA VDA

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ORTRAM Symbol	MATH Symbol	DESCRIPTION	ST BLDCI	ORAGE	LOC	SUBROUTINE USA		
			*					
SDA	K(3)	Explicit partial of $K^{(3)}$ art λ_{γ} when α is optimal.	/MATS	/(17)	ALGCOM AL1	0	GDA GDA
DA	κ <mark>γ*</mark> (3)	Explicit partial of $K^{(3)}$ wrt λ_{ϕ} when $lpha$ is optimal.	/MATS	/(16)	ALGCON AL1	I D	PDA PDA
m19		Not used	/MATS	/(19)			
M20		Not used	/MATS	1(20)			
M21		Not used	/MATS	/(21)			
M22		Not used	/MATS	/(22)			
KITT	K(I)	First entry in 3x6 metrix containing K _{mm}	/MATS	/(ALGCON TH3	0	XKIL
KITO		Description mot imput	/MATS	/(26)	TH3	M	XKIT
K2TD		Description met imput	/MATS	π.	27)	AL1 BL2	0	XKS1
KSTD		Description met imput	/MATS	/(28)	AL4 AL6 AL7 AL8 AL9	M 0 M 0 M	XK3T XK3T XK3T XK3T
KITA		Description not input	/MATS	/(29)	TH3	M	XK)T
K2TA		Description not input	/MATS	/(30)	ALI	1	XKZT
K3TA		Description mot imput	/MATS	/(31)	AL4 AL6 AL7 AL8 AL9	0 0 0 0	XX31 XX31 XX31 XX31 XX31
K 100		Description not imput	/MATS	/(32)	TH3	M	XKID
K200		Description not imput		11		AL1 DL2	I	XK20
K300	,	Description not imput	/MATS	/(34)	AL4 AL6 AL7 AL8 AL9	E 0 E 0 0	XK3[XK3[XK3[XK3[
K I DA		Description not input	/MATS	/(35)	TH3	Ħ	XKIC
KZDA		Description not imput	/MATS	/(36)	AL1	1	XK2
K3DA		Description not input	/MATS	/(37)	AL4 AL6 AL7 AL8 AL9	0000	XK3[XK3] XK3[XK3] XK3[
KIAA		Description not input	/MATS	/(38)	TH3	Ħ	XK16
K2AA		Description not input	/MATS	/(39)	AL1 DLZ	1	XK26
K3AA ,		Description not input	/MATS	K	40)	ALS ALS ALS ALS ALS ALS ALS	00000	XK3(XK3(XK3(XK3(XK3)
M41		Not used	/MATS	/(41)	#17	U	XK36
M42		Not used	/MATS	/(42)			
M43		Not used	/MATS	10	43)			
M44		Not used .	/MATS	/(44)	•		
M45		Not used	/MATS	/(45)			
KIV	K _V (1)	The first entry in a 3x8 matrix containing Ky	/MATS	/(96)	ALGCON ALGCON TH3 TH4	I M D	XK1/ XK1/ XK1/

SYMBOL	MATH Symbol		DESCRIPTION	STO	RAGE	GE SUBROUTINE !			USAG
1K2V		Description not	Input	/MATS	/(47)	DL2	0	XX2V
xk3A		Description not			/(AL1 AL3 AL4 AL5 AL6 AL7 AL8 AL9	000000	XK3A XK3A XK3A XK3A XK3A XK3A XK3A
XK36		Description mot	imput	/MATS	K	51)	ALI ALI ALI ALB AL9	0000	1K36 1K36 1K36 1K36
XK3P		Bescription not	Imput	/MATS	/(54)	AL7 AL8 AL9	0 0	XK3P XK3P XK3P XK3P
XKJA		Description not	input	/MATS	/(55)	TH2 TH3 TH4	0 # 0	XK1R XK1R XK1R
KK2R		Description not	Input	/MATS	16	56)	DTS	8	XX2R
X K 3 R		Description met		/RATS	<i>/</i> ('	57)	AL1 AL3 AL4 AL5 AL6 AL7 AL8 AL9	00080000	XK3R XK3R XK3R XK3R XK3R XK3R XK3R
XK30		Description not	lmput	/MATS	/(60)	AL4 AL7 AL8 AL9	0	XK30 XK30 XK30
XX1m		Description mat	imput	/MATS	/(64)	TH3	M	XKIM
XK2M		Description not	input	/MATS	/(65)	DLZ	0	XK2M
XK3M		Description mot			К		ALI ALG AL5 AL6 AL7 AL8 AL9	0 8 0 0	X K 3 M X K 3 M
XK1Z		Description not	•				TH2	0	XK1Z
XK1VT	K(I)		in a 3x3 matrix containing K _{vs}				ALSCON TH3	Ä	XK1AL XKMA
XK3VT	•	Description not	·				AL9	0	XK3VT
XKIAD		Description not	-				TH3	Ħ	XKIVD
XK3VD XK3VD		Description not Description not	•		70		AL1 AL4 AL9	I D O	XK3AD XK5AD
XK1VA		Description not	Innut	/MATS	/(761	TH3	Ħ	XK3VD
XK2VA		Description not	·				AL1 DL2	I D	XK2VA XK2VA
XK3VA		Description not	input	/MATS	K	78)	AL3 AL4 AL5 AL6 AL7 AL8 AL9	00000	XK3AW XK3AW XK3AW XK3AW XK3AW XK3AW
XK16T 10 NDV 72	K ⁽¹⁾ 6.01-47	The first entry	in a 3x3 matrix containing K _{2m}	/MATS	/(79)			

		ORTRAN MATH Symbol Symbol		DESCRIPTION	BLOCK	ORAGE	LOC	SUBR	COOE	USAGE VAR
MASS Description not input		** 3CT	Description and	lanut	/mate	,,	g1 v	A1 #	Λ .	**361
MASS	Description not input		*	•						
MATS	Capt			-						
Mars	Color								٠	
		*⊬j	•							
March Marc	CLASS	XK3PT	· •	·						
Marcon	Commonwealth Comm	XK3PD	•							
	Description mot input	XK3PA	•	·						
	Comparison and imput Comparison Compar	XKIRT K(1)	The first entry	in a 313 matrix containing K _{he}	/MATS	/(91)	TH3	M	XKIRT
NEAR Description not input	ALP 0 KSANT	XK3RT	Description not	input	/MATS	/(99)	AL7	0	XK3RT
	Description not input									
Description not input	Description not input	XK1RD	Description not	input	/MATS	/(100)	TH3		
RECORD		XK2RD	Description not	Input	/MATS	/(101)	AL1	1	XK2AB
REST Description not input	Company Comp	KK3RD	Description not	Input	/MATS	/(102)			
RESIDE Description not input MATS 103 TM3 M XEIRA RESIDE MATS 104 ML1 I XEZRA MESTA Description not input MATS 104 ML1 I XEZRA ML5	Also 0 1 1 1 1 1 1 1 1 1									
	Description not input									
READ Description not input	Description not input Desc	KKIRA	Description not	input	/MATS	/(103)	THS	M :	XKIRA
Description not input	Comparison of input	XK2RA	Description not	input	/MATS	/(104)			
AL	ALS X438A	KK3RA	Description mat	input	/mats	/(105)			
RKRIOT Kara	ALSO XKSAM XKSAM XKS		accorrection 49 t			.,		AL4 AL5 AL6 AL7	0 M 0	XK3RA XK3RA XK3RA XK3RA
REST Description not input	Description not input	<u>:</u>								
RESOR Description not input /MATS /(108) AL4 0	Description not imput	K ([)	The first entry	in a 3x3 matrix containing K _{pm}	/MATS	/(106)			
Description not input		ام kk30t	Description not	input	/MATS	76	108)	AL4	0	XK30T
Description not input	Description not imput	XK30D	•							
XKIUT K	The first entry in a 3x3 matrix containing K	XK30A		·						
XKIMT K(1) The first entry in a 3x3 matrix containing K MATS (124) TH3 M XKIMT	(1MT K(1) The first entry in a 3x3 matrix containing Kmm /MATS /(124) TH3 M XK1MT (2MT Description not input /MATS /(125) BL2 O XK2MT (3MT Description not input /MATS /(126) AL7 O XK3MT AL8 O XK3MT (1MD Description not input /MATS /(127) TH3 M XK1MD (2MD Description not input /MATS /(128) AL1 I XK2MD (3MD Description not input /MATS /(129) AL7 O XK3MD AL8 O XK3MD (1MA Description not input /MATS /(129) AL7 O XK3MD AL8 O XK3MD (1MA Description not input /MATS /(130) TH3 M XK1MA (2MA Description not input /MATS /(131) AL1 I XK2MA (2MA Description not input /MATS /(131) AL1 I XK2MA (2MA Description not input /MATS /(131) AL1 I XK2MA (2MA Description not input /MATS /(131) AL1 I XK2MA AL6 O XK3MA AL7 O XK3MA AL8 O XK3MA AL9 O XK3MA AL9 O XK3MA AL9 O XK3MA AL9 O XK3MA AL7 O XK3MA AL8 O XK3MA AL9		•	•						
	Comparison of input	ŤμŤ						THO	_	YK 1 MT
MATS	Description not imput	K(1)	THE TIEST ENTRY	a 222 mattix coursibled # ##	/8813	′`	164)	143	~	*****
ALB 0 XKSMT AL9 0 XKSMD AL8 0 XKSMD AL9 0	ALB 0 XX3MT ALP 0 XX3MT XX1MD DESCRIPTION NOT INDUT /MATS /(128) ALI 1 XX2MD DL2 0 XX2MD ALB 0 XX3MD ALP 0 XX3MD	XK2MT	Description not	Input	/MATS	/(125)	DL2 .	0	XK2MT
XKIMD Description not input	Cambo	XK3MT	Description not	Input	/MATS	/(126)	ALB	0	XK3MT
Compared	Description not input									-
DESCRIPTION NOT INPUT	Dic	KKIMD	•	•						
Description not input	Description not input	XK2MD	Description not	input	/MATS	10	128)			
AL9 0 .XK3MD XK1MA Description not input	AL9 0 XK3MD	XK3MD	Description not	Input	/MATS	/(129)	AL7	8	XK3MD
XKIMA Description not input	CIMA Description not input							AL8	0	XK3MD
XK2MA Description not input	Came	XKIMA	Description not	input	/MATS	/(130)			
DL2 0 XK2MA XK3MA Description not input /MATS /(132) AL4 0 XK3MA AL5 M XK3MA AL6 0 XK3MA AL7 0 XK3MA AL7 0 XK3MA AL8 0 XK3MA AL8 0 XK3MA AL9 0 XK3MA XK1ZT K(1) The first entry in a 3x3 matrix containing K ₇₈ /MATS /(133)	OL2 0 XK2MA (3MA Description not input /MATS /(132) AL4 0 XK3MA	XK2MA	•	•					1	XK2MA
ALS M XK3MA AL6 O XK3MA AL7 D XK3MA AL8 O XK3MA AL8 O XK3MA AL9 D XK3MA XK1ZT K(1) The first entry in a 3x3 matrix containing K ₇₈ /MATS /(133)	AL5 M XK3MA AL6 D XK3MA AL7 D XK3MA AL8 D XK3MA AL9 D XK3MA AL9 D XK3MA (IZT K(I) The first-entry in a 3x3 matrix containing K _{TM} /MATS /(l33)		·	·				OL2	0	XK2MA
AL9 D XK3MA XKIZT K([) The first-entry in a 3x3 matrix containing K _{rm} /MATS /(133) XT	AL9 D XK3MA (IZT K([]) The first entry in a 3x3 matrix containing K ₇₈ /MATS /(133) 7T	XK3MA	Description not	Input	/MATS	/(132)	AL5 AL6 AL7	0	XK3MA XK3MA XK3MA
^-T	N-1							AL9		
		XK1ZT K(1)	The first-entry	in a 3x3 matrix containing K _{rm}	/MATS	/(133)			
		0 NOV 72 6.01-47								
								•		-
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FORTRAM Symbol	MATH Symbol		DESCRIPTION	ST BLOCI	ORAG	FOC	SUBROUT!	NE USAGE DE VAR
								·
XKIVV	K(1)	The first entry	in a 3x8 matrix containing Kyw	/MATS	/(142)	ALGCON I	
	**						TH4 0	
XK5AA		Description not	·	/MATS	/(143)	DL2 0	XKZVV
XK3AA		Description not	input	/MATS	/(144)	AL3 D	
							AL5 M	XK 3 4 A
							AL6 0 AL7 0	
							ALS 0	XK3VV
*******		0	t				AL9 D	
xx36v		Description not	1 Aput	/MATS	/([47)	AL4 0 AL7 0	
							AL8 0	X4636A
XK3PV		Description nat	•	/MATS	/(150)		XK3PV
XKIRV		Description not	•	/MATS	/(151)		
XK2RV		Description not	•	/MATS	/(152)		
xK3RV		Description not	Imput	/MATS	/(153)	AL3 0 AL4 0	XK3BA XK3BA
			•				AL5 M	XK3RV
							AL6 D AL7 D	
							ALB D	XK3RV
XK30A		Description met	lanet	/MATS	/C	156)		XK30V
XKIMV		Description not	•	/MATS	/(160)		
XK2MV		Description net	•		/(161)		
XK3MV		Description not	· · · ·	/MATS		162)		XK3MY
		,		•			AL5 M AL6 0	XK 3WA
							AL7 0	XK3WA
XK166		The first ent	in a 3x7 matrix containing K _{y2}	/MATS	,,	1441	ALS 0	XK3MV
	K(1)		•					****
xk3ee		Description mot	Input	/MATS	/(168)	AL7 0	
							AL8 0	XK366
XK3PG		Description met	inant	/MATS	,,	1711	AL9 0	X K 3 F G
	•			,.,,,,	•	,	AL7 0	XK3P6
XK3RG		Description aut	land	/==Tr	,.	17=	ALB D	
ANJING		. Description mot	· mput	/MATS	/()	AL7 0	
							AL8 0 AL9 3	XX3RG
X X 3 O G		Description not	input	/MATS	/(177)		
		•	•		•	•	AL7 0	X K 30 G
XK3M6		Description not	laput	/MATS	/1	1821	ALB 0	
XK1PP	υ(1)		in a 3x6 matrix containing K _{yp}	/MATS		187)		-43110
	K 44 (1)		•					
XK3PP		Description met	Input	/MATS	/(189)	AL4 0 AL7 0	
			•				ALS D	XK3PP
A4300		Description - *	I-a-+	,	,,	100.	AL9 0	•
XK3RP		Description mot	INPUT	/MATS	/(142)	AL4 0 AL7 .0	
							AL8 0	XK3RP
XK30P		Description not	least	/MATS	,,	1951		
AN 301		0431ption #81		/nm13	,,	. 171	AL7 0	XX30P
Ah 2		0	I no uh	,			ALS C	
XK3MP 10 NOV 72	G.01-47	Description not	input ·	/MATS	71	201)	AL4 0	XK3MP

FORTRAN	MATH	DESCRIPTION	<u> </u>	ORA		SUBRO	ITIN	USAGE
SYMBOL	SYMBOL	DESCRIPTION	BLOC	K	roc	SUBR	COD	VAR
XKIRR	K(I)	The first entry in a 3x5 matrix containing Kyh	/MATS	/(205)	TH2 TH3 TH4	0 M	XK 1AR XK 1AR XK 1AR
XK2RR		Description apt Imput	/MATS	/(206)		0	XK2RR
XK3RR		Description not input	/MATS	70	207)	AL3 AL4 AL5 AL6 AL7 AL8 AL9	0 0 0 0	IK 3RR IK 3RR IK 3RR IK 3RR IK 3RR IK 3RR
XK3DR		Description not input	/MATS	/(210)	AL9 AL7 AL8	0 0 0	1430R 1430R 1430R
XKIMR		Description not imput	/MATS	/(214)	THE	R	XK 1 MR
XK2MR		Description mot input	/MATS	/(215)	DL2	0	XK2MR
XK3MR		Description not input	/MATS	/1	2)4)	AL9 AL5 AL6 AL7 AL8	0 0 0	IK3MR IK3MR IK3MR IK3MR IK3MR
XK100	K(1)	The first entry in a 3x4 matrix containing K _{yp}	/MATS	/(220)			
XK300	`` p p	Description not input	/MATS	/(222)	AL4 AL7 AL8 AL9	0	XK300 XK300 XK300 XK300
XK3MD		Description not input	/MATS	/(228)	_	0	XK3MD
XKIUU	K(I)	The first entry in a 3x3 matrix containing Kyu	/MATS	/(232)			
XK1MM	μμ <u>κ</u> (1)	The first entry in a 3x2 matrix containing Kym	/MATS	/(241)	TH3	m	XX1MM
XK2MM	~	Description not imput	/MATS	/(242)	01.2	0	XK2RM
XK3MM		Description not input	/MATS	'n	243)		0 8 0 0	XK3MA XK3MA XK3MA XK3MA XK3MA XK3MA
XK1ZZ	K(1)	The first entry in a 3x1 metrix containing $K_{\mu\nu}$	/MATS	/(247)	THZ	0	XK1ZZ
XKP111		The first entry in the 3x3 matrix $-K^{-\frac{1}{2}}$	/MATS	/(250)	ALECO		XKPI11
XKP121		Description not input	/MATS	/(251)	ALGCO	0	XKPI21
XKP131		Description not imput	/MATS	/(252)	ALGCO	0	XKP131
XKPI12		Description not input	/MATS	/(253)	AL6CO!	0	XKPI12
XKP122		Description not input	/MATS	/(254)	ALGCO	4 C	XKP122
XKP132		Description not input	/MATS	/(255)	ALGCO	0	XKP132
XKP113		Description not input	/MATS	/(256)	ALGCO	8	XKP113
XKPI23		Description not input	/MATS	/(257)	ALGCO	8 0	XKP123
XKP133		Description not input	/MATS	/(258)	ALGCO	0	XKPI33
PA1		Not used	/MATS	/(259)	ALGCO	. 0	PAL
PAZ		-K(2)/K(2)	/MATS	/(260)	ALGCO!	0 8	PAZ PAZ
DPDY	∂ ≢/∂y	A 3x8 matrix that contains the total first partial derivatives of the in-plane-control vector ært the QL state.	/MATS	/(261)	ALGCO!	1 1	DP DY DP DY
DEPDEY	δρ/δγ	A 2x8 watrix that contains $\delta \rho/\delta y = \partial \rho/\partial y \Big _{0} = constant$	/MATS	/(285)	ALGCO!		DEPDEY DEPDEY

1

ORTRAN Symbol	MATH Symbol	DESCRIPTION	810C	ORAG	FOC	SUBROU.	.00	E USAGI
			··········					
DPOL	9 m /9y	A 3x3 matrix that contains $\partial u/\partial \lambda_y$, $\partial g/\partial \lambda_y$ and $\partial u/\partial \lambda_\psi$	/MATS	/(301)	ALSCOM APPLY	1	DPDL DPBL
PROD2	a(6p/6y)/ay	A 2x64 matrix that contains the total first partials of the matrix DEPDEY art the QL state.	/MATS	/(310)	ALGCOM ALGCOM APPLY APPLY	I 1 I 1	PROD1 PROD1 PROD1 PROD5
PRODS	a(am/ ay)/ ay	A 3x64 matrix that contains the total first partials of the matrix DPDY mrt the OL state.	/MATS	/(310)			
PROD9		A 2x64 matrix that contains $\partial(\delta p/\delta y)/\partial \lambda_y$, $\partial(\delta p/\delta y)/\partial \lambda_y$	/MATS	/(502)	ALGCOM APPLY	I	PR009
> v	••	and d(Sp/Sy)/dly. See symbol	/MATS	/(550)		Ħ	PV
P G	•,	See symbol .	/MATS	11	551)	AL4 APPLY ARCIN CONTRL	M 1 0 0	PG PG PG PG
PP	**	See symbol	/MATS	/(552)	AL4	Ħ	PP
PR	•	See symbol	/MATS	/(553)	AL4	M	PR
PO	• ,	See symbol	/MATS	/(554)	AL4	Ħ	PO
PVV	*. ,	See symbol	/MATS	/(555)	AL4	Ħ	PVV
PGV	* ,,	See symbol	/MATS	/(556)	AL4	M	PGV
PPV	***	See symbol	/MATS	/(557)	AL4	M	PPV
PRV	***	See symbol	/MATS	/(558)	AL4	M	PRV
POV	***	See symbol	/MATS	/(559)	AL4	m	POV
966	+ 22	See symbol	/MATS	/(560)	AL4	Ħ	P66
PPS	++,	See symbol	/MATS	/(561)	AL4	Ħ	PPG
PRG	4 h7	See symbol	/MATS	/(562)	ALG	M	PRG
P06	+ o,	See symbol	/MATS	/(563)	AL4	M	P06
PPP	***	See symbol	/MATS	/(564)	AL4	Ħ	PPP
PRP	# hu	See symbol	/MATS	/(565)	AL4	M	PRP
POP	**	See symbol	/MATS	/(566)	ALA	•	POP
PRR	Abb	See symbol	/MATS	/(567)	AL4	M	PRR
POR	ø _{øh}	See symbol	/MATS	/(568)	AL4	m	POR
P00	* pp	See symbol	/MATS	/(569)	AL4	M	P00
PL6	φ _λ ,	See symbol	/MATS	/(570)	APPLY ARCIN CONTRL	1 0 0	PLG PLG PLG
PLP	*x*,	See symbol	/MATS	/(571)	APPLY ARCIN CONTRL	I	PLP PLP PLP

BLØCK ØRBIT

FORTRAN Symbol	MATH Symbol	DESCRIPTION		BLOCK	LOC	SUBROUTII	
3111600	3111000			DEUCK	LUC	308K CU	DE VAN
٧1	v _I	Inertial velocity	(FT/SEC)	/ORBIT /(1)	OUTPUT 1 POBCQL 1 POBCQL M	
ORBPRM		Array of intertial and orbital boundary condit		/ORBIT /			
GAMI	> ₁	Inertial flight path angles	(RAD)	/ORBIT /	2)	POBCOL D	GAMI
PSII	≠ 1	Inertial azimuth	(RAD)	/ORBIT /	3)	OUTPUT I	PSII PSII
IMUI	μ,	Inertial longitude	(RAD)	/08BIT /0	4)	BUTPUT I	IMMI
P	P _r	Semi-latus rectum	(FT)	/ORBIT /	5)	OUTPUT I	I MUI
ECC	e	Orbital accentricity		/ORBIT /	6)	POSCOL #	P ECC
AIRCL	ī	Orbital inclination	(RAD)	/ORBIT: /C	7)	PDBCQL M	ECC Alwcl
ARGP		Orbital argument of perigee	(RAD)	/ORBIT /		POBCOL MOUTPUT I	AINCL
AXCNOD	0 p					POBCOL M	ARGP
	Ω	Longitude of ascending made	(RAD)	/ORBIT /		POBCOL M	ASCNOD ASCNOD
LAMIMS	a s	Semi-major axis	(FT)	/ORBIT /(10)	OUTPUT I POBCOL M	SMIMAJ SMIMA
APOGEE	R.	Apagee radius	(FT)	/ORBIT /(11)	OUTPUT I	APOGEE APOGEE
PERGEE	R	Perigee redius	(FT)	/ORBIT /	12)	OUTPUT I	PERGEE
ANDMLY	\$	True anomoly	(RAD)	/ORBIT /(13)	OUTPUT I	ANOMLY
CAPX	x	Asymptote parameter	τ	/ORBIT /(14)	POBCGE A	CAPE
CAPY	Y	Asymptote parameter	(FT)	/ORBIT /	15)	POBCAL 0	CAPY
ASYMP	8	Outgoing asymptote	(RAD)	/ORBIT /(16)	PDBCQL M	ASYMP
ENERGY	E	Energy		/ORBIT /	17)	OUTPUT I	ENERGY
HMNTM	н	Momentum		/ORBIT /	18)	POBCOL O	ENERGY HANTA
DAIDA		Partial derivative of boundary condition		/ORBIT /(19)	POBCOL M POBCOL M POBCOL 1	DVI DV PPO
PPO		Matrix of boundary condition partial derivativ	es	/ORBIT /(19)		
DAIDE		Partial derivative of boundary condition		/ORBIT /(20)	POBCQL M	DAIDE
HGIVO		Partial derivative of boundary condition		/ORBIT /(21)	PDBCQL #	BAIDM
DVIDM		Partial derivative of boundary condition		/ORBIT /(POBCOL 0	DAIDW
DVIDPS		Partial derivative of boundary condition		/ORBIT /(PDBCOL #	DVIDPS
DVIDAU DVIDAU		Partial derivative of boundary condition		/ORBIT /(_	PDBCQL #	DVIDRO
061DA 041MM		Partial derivative of boundary condition		/ORBIT /(PDBCQL 0	DAIDWA
D6106		Partial derivative of boundary condition Partial derivative of boundary condition		/ORBIT /(PDBCQL M	D61D6 D61DA
0610H		Partial derivative of boundary condition		/ORBIT /(POBCOL M	DEIDM
D618M		Partial derivative of boundary condition		/ORBIT /(PDBCQL 0	DGIDM
DGIDPS		Partial derivative of boundary condition		/ORBIT /(POBCOL M	DEIDPS
DGIDRO		Partial derivative of boundary condition		/ORBIT /(PDBCOL A	DGIORO
DGIDMU		Partial derivative of boundary condition		/ORBIT /(PDBCQL 0	0610#0
PIDV		Partial derivative of boundary condition		/ORBIT /(POBCOL #	DPIDV
		Partial derivative of boundary condition		/ORBIT /(POBCOL M	DPIDG

ORIRAN Symbol	MATH Symbol	DESCRIPTION	STORAGE Block LOC	SUBROUTINE SUBR CODE	USA
PION		Partial derivative of boundary condition	/ORBIT /(35) POBCOL M	BPID
PIDM		Partial derivative of boundary condition	/0RBIT /(36) POBCOL O	OPID
PIDPS		Partial derivative of boundary condition	/ORBIT /(37) PBBCQL M	OPIDE
PIDRO		Partial derivative of boundary condition	/ORBIT /(38) P06CQL M	00100
PIDAU		Partial derivative of boundary condition	/ORBIT /(39) PDBCQL D	DPID
MIDV		Partial derivative of boundary condition	/ORBIT /(40) POBCAL D	DMID
MIDG		Partial derivative of boundary condition	/ORBIT /(41) POSCAL O	DAID
MIDH		Partial derivative of boundary condition	/ORBIT /(42) PDBCQL 0	DMID
MIDM		Partial derivative of boundary condition	/ORBIT /(43) POSCOL O	DMID
MIDPS		Partial derivative of boundary condition	/ORBIT /(44) POSCOL D	DAID
MIDRO		Partial derivative of boundary condition	' /ORBIT /(45) POBCAL O	DMID
UNGIN		Partial derivative of boundary condition	/ORBIT /(46) POBCOL O	DAID
PDV		Partial derivative of boundary condition	/ORBIT /(47) PDBCQL #	DPOV
PDG		Partial derivative of boundary condition	/ORBIT /(48) POBCQL M	DPD6
PDH		Partial derivative of boundary condition	/ORBIT /(49) POBCQL M	DPDH
PDM		Partial derivative of boundary condition	/ORBIT /(50) POBCQL 0	DPDM
PDPS		Partial derivative of boundary condition	/ORBIT /(51) POBCQL M	DP 0P
PDRO		Partial derivative of boundary condition	/ORBIT /(52) POBCOL M	DPDR
PDMU		Partial derivative of boundary condition	/ORBIT /(53	POBCOL O	DPDM
ECDV		Partial derivative of boundary condition	/ORBIT /(54) POBCAL M	DECO
ECDE		Partial derivative of boundary condition	/ORBIT /(55) POBCOL M	DECO
ECDH		Partial derivative of boundary condition	/ORBIT /(56) POBCOL M	DECO
ECDM		Partial derivative of boundary condition	/ORBIT /(51) POBCQL 0	DECO
ECOPS		Partial derivative of boundary condition	'/ORBIT /(58) PDBCQL M	DECD
ECORO		Partial derivative of boundary condition	/ORBIT /(59) POBCGL M	OECO
ECDAU		Partial derivative of boundary condition			DECD
IDV		Partial derivative of boundary condition	/ORBIT /(61) POBCAL M	DIDV
IDG		Partial derivative of boundary condition	/ORBIT /(62) POBCOL M	0106
IDH		Partial derivative of boundary condition	/ORBIT /(63) POBCOL M	DIDE
I DM		Partial derivative of boundary condition			010
IDPS		Partial derivative of boundary condition			DIDE
10R0		Partial derivative of boundary condition			DIDE
IDMU		Partial derivative of boundary condition			DIDA
BEDY		Partial derivative of boundary condition			DBED
BED6		Partial derivative of boundary condition			DBEO
BEDH		Partial derivative of boundary condition			DBED
BEDM		Partial derivative of boundary condition			DBED
BEDPS		Partial derivative of boundary condition			DBED
BEDRO	,	Partial derivative of boundary condition			DBEC
BEDMU		Partial derivative of boundary condition			DBEC
NOBY		Partial derivative of boundary condition			DNOC
ADDE		Partial derivative of boundary condition			DNO
HODH		Partial derivative of boundary condition			DNOO
MOGM		Partial derivative of boundary condition			DNOD
NODPS		Partial derivative of boundary condition			DNOD
NOORO		Partial derivative of boundary condition			DNO
NODMU		Partial derivative of boundary condition			DNO
SMDV		Partial derivative of boundary condition			DSME
-		Partial derivative of boundary condition	/ORBIT /(83		DSAC

ORTRAN YMBOL	SYMBOL	DESCRIPTION	STORAGE BLOCK LOC	SUBROUTINE US SUBA CODE V
SMOH		Partial derivative of boundary condition	/ORBIT /(64)	POBCOL M DSM
SMDM		Partial derivative of boundary condition	/ORBIT /(85)	POSCOL D DSM
SMOPS		Partial derivative of boundary condition	/ORBIT /(86)	POSCOL M DSM
SMORO		Partial derivative of boundary condition	/ORBIT /(87)	POBCEL M DSM
SMDMU		Partial derivative of boundary condition	/ORBIT /(88)	POBCAL D DSM
APDV		Partial derivative of boundary condition	/ORBIT /(89)	POSCOL D DAP
APDG		Partial derivative of boundary condition	/GRBIT /(90)	POBCOL O DAP
APDH		Partial derivative of boundary condition	/ORBIT /(91)	POBCOL O DAP
APDR		Partial derivative of boundary condition	/ORBIT /(92)	POBCAL D DAP
APDPS		Partial derivative of boundary condition	/ORBIT /(93)	POSCOL O DAP
APDRO		Partial derivative of boundary condition	/ORBIT /(94)	POBCOL O DAP
APDMU		Fartial derivative of boundary condition	/DRBIT /(95)	POBCAL O DAP
PEDV		Partial derivative of boundary condition	/ORBIT /(96)	POBCAL O DPE
PED6		Partial derivative of boundary condition	/ORBIT /(97)	POBCAL O DPE
PEDH		Partial derivative of boundary condition	/ORBIT /(98)	POBCAL O DPE
PEDM		Partial derivative of boundary condition	/DRBIT /(99)	POBCAL D DPE
PEDPS		Partial derivative of boundary condition	/ORBIT /(100)	POBCAL O OPE
PEDRO		Partial derivative of boundary condition	/ORBIT /(101)	POBCAL O BPE
PEDMU		Partial derivative of boundary condition	/ORBIT /(102)	POBCAL O DPE
ANDV		Partial derivative of boundary condition	/ORBIT /(103)	POBCAL D DAN
ANDG		Partial derivative of boundary condition	/ORBIT /(104)	PDBCOL O DAM
ANDH		Partial derivative of boundary condition	/ORBIT /(105)	POBCOL O DAM
MDM		Partial derivative of boundary condition	/ORBIT /(106)	POBCAL 8 BAN
ANDPS		Partial derivative of boundary condition	/ORBIT /(107)	POBCQL O BAN
ANDRO		Partial derivative of boundary condition	/ORBIT /(108)	PDBCQL 0 DAM
ANDRU		Partial derivative of boundary condition		POBCOL O DAM
CXDA		Partial derivative of boundary condition	/ORBIT /(110)	POBCOL O OCX
CXDG		Partial derivative of boundary condition	/OABIT /(111)	POSCOL O DEX
CXDH		Partial derivative of boundary condition	/ORBIT /(112)	POBCOL O DCX
CXDM		Partial derivative of boundary condition	/ORBIT /(113)	PRECEL D BCX
CXDPS		Partial derivative of boundary condition	•	POBCOL O OCX
CXBRD		Partial derivative of boundary condition	/ORBIT /(115)	PDBCQL O DCX
CXDMU		Partial derivative of boundary condition	/ORBIT /(116)	POSCOL O DCX
CYDV		Partial derivative of boundary condition	/ORBIT /(117)	PDBCQL O DCY
CYD6		Partial derivative of boundary condition	/ORBIT /(118)	PDBCQL 0 BCY
CYDH		Partial derivative of boundary condition	/ORBIT /(119)	POBCOL O DCY
CYDM		Partial derivative of boundary condition	/ORBIT /(120)	PDBCQL 0 DCY
CYDPS		Partial derivative of boundary condition	/ORBIT /(121)	PDBCQL 0 DCY
CYDRO		Partial derivative of boundary condition	/ORBIT /(122)	PDBCOL O DCY
CYDMU		Partial derivative of boundary condition	/ORBIT /(123)	POBCOL O DCY
ASDV		Partial derivative of boundary condition	/ORBIT /(124)	POBCOL O BAS
ASDG		Partial derivative of boundary condition	/ORBIT /(125)	POBCOL O DAS
ASDH		Partial derivative of boundary condition	/ORBIT /(126)	POBCOL D BAS
ASDM		Partial derivative of boundary condition	/ORBIT /(127)	POBCOL O DAS
ASDPS		Partial derivative of boundary condition		POBCOL O DAS
ASORO		Partial derivative of boundary condition	/ORBIT /(129)	POBCOL O DAS
ASDMU		Partial derivative of boundary condition		PDBCQL 0 DAS
ENDV		Partial derivative of boundary condition	/ORBIT /(131)	POBCOL O DEM
		Partial derivative of boundary condition	/ORBIT /(132)	

		DESCRIPTION		BLOCK	FOC	SUBR COO	E VAR
DENDH		Partial derivative of boundary condition		/ORBIT /	(133)	PDBCQL O	DENDH
DENDM		Partial derivative of boundary condition		/ORBIT /		POBCOL O	DENDA
DENDPS		Partial derivative of boundary condition		/ORBIT /	(135)	POBCOL O	DENDPS
DENDRO		Partial derivative of boundary condition		/ORBIT /	(136)	POBCOL O	DENDRO
DENDMU		Partial derivative of boundary condition		/ORBIT /	(137)	PDSCOL 0	DENDMU
VGORG		Partial derivative of boundary condition		/ORBIT /	(138)	PDBCQL 0	DMODV
DMODG		Partial derivative of boundary condition		/ORBIT /	(139)	PDBCQL 0	DM006
HODMO	•	Partial derivative of boundary condition		/ORBIT /	(140)	PDBCOL D	DMODH
DMODM		Partial derivative of boundary condition		/ORBIT /	(141)	PDBCOL 0	DMODM
DMODPS		Partial derivative of boundary condition		/ORBIT /	(142)	PDBCQL D	DMODPS
DMODRO		Partial derivative of boundary condition		/DRBIT /	(143)	POBCOL O	DADDRO
DMODMU		Partial derivative of boundary condition		/ORBIT /	(144)	POSCOL 0	DADDAN
YMXRF	Pr	Reference longitude	(RAD)	/ORBIT /	(145)	CHECK 0	YMIRF YMIRF
SNXLMR	sin(ρ-ρ _Γ)	Sine of reference latitude		/ORBIT /	(146)	CHECK D	SMXLMR SMXLMR
CSXLAR	cos(ρ-ρ _ε)	Cosine of reference latitude		/ORBIT /	(147)	POBCOL I	CSXLAR CSXLAR
SDDWN	S _D	Down range	(FT)	/ORBIT /	(148)	DUTPUT I PDBCQL O	S D O WAN S D O WAN
SCROSS	s _c	Cross range	(FT)	/ORBIT /	(149)	OUTPUT I PDBCQL O	SCROSS SCROSS
TD	f _D	Down range angle	(RAD)	/ORBIT /	(150)	PDBCQL #	TO .
TC	θ _c	Cross range angle	(RAD)	/ORBIT /	(151)	PDBCQL M	TC
SNPSR	sin(♥ _r)	Sine of reference azimuth		/ORBIT /	(152)	CHECK O	SNPSR SNPSR
CSPSR	cos(√ _r)	Casine of reference azimuth		/ORBIT /	(153)	CHECK D	CSPSR CSPSR
5 161	sin(7 ₁)	Sine of inertial flight path angle		/ORBIT /	(154)	PDBCQL #	SMBI
CSGI	cos(2,)	Cosine of inertial flight path angle		/ORBIT /	(155)	POSCOL M	CSGI
SPSII	sin(\v_i)	Sin of inertial azimuth		/ORBIT /	(156)	PDBCQL M	SPSII
CSPSII	cos(*()	Cosine of inertial azimuth		/ORB1T /	(157)	POBCOL M	CPSII
STOT	S _T	Total range	(FT)	/ORBIT /	(158)	OUTPUT I POBCOL 0 OLTOSZ I	STOT STOT STOT
CSI	cos(1)	Cosine of inclination		/ORBIT /	(159)	POBCOL A	CSI
SNI	sin(1)	Sine of inclination		/ORBIT /	(160)	POBCOL #	SMI
SNGNU	sin(v)	See symbol		ORBIT /	(161)	POBCOL M	SNEWU
CSAND	cos(\$)	See symbol		/ORBIT /		POSCOL #	CSANO
COSDMU	cos(µ-µ_)	See symbol		/ORBIT /		POBCEL A	COSDAU
SINDAU		See symbol		/ORBIT /		POBCOL M	SINDAU
THT	sin(μ-μ _r) θ _T	Total range angle	(FT)	/ORBIT /		POSCOL M	THT
	σ ₁		,,,,		. 1077		

BLØCK PC

SYMBOL .	MAIH Symbol	DESCRIPTION	BLO.	TORAC CK	LOC			E USAG E VAR
PC1		Not used	/PC	/(1)	GROPE	Ð	PC
*		Total number of OL state and costate variables. N = 18.	/PC	/(2)	BNDRY CHECK INARC LINDRY NLORY NOMMAL RKUTTI SALVE WRAPUP	i I I	
PC3		Not used	/PC	/(3)			
I DP		Component number that corresponds to the QL state variable > IDP = 8.	/PC	/(4)	I NARC WRAP UP	I	I DP I DP
PC5		Not used	/PC	/(5)			
PC6		Not used	/PC	/(6)			
PC7 .		Not used	/PC	10	7)			
MAXBC		Maximum number of target conditions that QL can bandle. MAXBC = 40	/PC	/(8)			
NAUX		Number of velocity loss quantities to be integrated an converged trasectory. MALX = 5.	/PC	/(9)	WR AP UP	I	MAUX

BLØCK PRINT

FORTRAN	MATH	DESCRIPTION	STORAGE SUBROUTINE USAGE
Symbol	Symbol		BLOCK LOC SUBR CODE VAR
AP		Description not input	/PRINT /(1) OUTPUT # AP

BLØCK S



FORTRAM Symbol	MATH Symbol	DESCRIPTION	- SLO	TORAGE CK	roc	SUBROU Subr	USAGE VAR
5		An 820 word erray used to store the perticular and homogeneous solutions.	/\$	/(1)	NOMMAL REUTT1	\$ \$

BLØCK SIZING

ORTRAN Symbol	MATH Symbol	DESCRIPTION	BLOCK	LOC .	SUBROUTINE USAGE
QP .		Description not input	/\$1Z146/(5)	QLTOSZ D QP
2		Description not input	/\$121 4 6/(20)	QLTOSZ D PZ
Ľ		A synthesis array (20) containing counters and sizing options	/SIZING/(26)	OLTOSZ O SM
٧		A synthesis erray (28) containing staging parameters and misc flags	/\$121 M G/(46)	ENVPRO M SV OLTOSZ M SV
9		A synthesis data array (37,5) that contains the flyback data and some imjection quantities	/\$121MG/(74)	ENVPRO M SQ OLTOSZ M SQ
E		Array of synthesis iteration propulsion parameters	/\$121 46/ (259)	
LIM		Saved value of maximum dynamic pressure.	/S12146/(264)	EMYPRO M OLIM
BO .		Booster burnout weight (16)	/\$121 46 /(272)	
.00		Previous iteration value of booster liftoff meight (1b)	/5121 46/ (273)	
MEB		Sensitivity of booster stage meight to propellant meight (lb/lb)	/\$1Z1 46 /(274)	
MEO		Sensitivity of orbiter stage weight to propellant meight (lb/lb)	/512146/(275)	
OLWT		Booster liftoff weight sizing tolerance (16)	/SIZING/(276)	
PB		Booster propellant weight (16)	/\$121 46 /(217)	
IRAT2		Second stOge thrust-to-meight ratio	/\$1Z1MG/(278)	
K 1		Value of constant weight in booster stage weight equation	/\$121 mg /(279)	
(2		Value of linear term coefficient in booster stage meight equation	/\$121 46 /(280)	
K3		Value of 1/3-power term coefficient in booster stage weight equation	/\$12146/(281)	
(4		Value of 2/3-power term coefficient in booster stage weight equation	/SIZING/(282)	
SIZE		Sizing option flag 1. Fixed wlo, maximize xpl 2. Fixed xpl, minimize wlo 3. Fixed orbiter, minimize wlo 4. Fixed booster, minimize wlo 5. Fixed (t/w)1.0. Maximize xpl 6. Fixed (t/w)1.0. Determine f	/\$1Z1#6/(283)	
RAFLG		Traffic control flag O. Sizing loop not converged 1. Sizing loop converged 2. Error in sizing loop next case	/5121 46 /(284)	
WRATO		Liftoff thrust-to-meight ratio	/512146/(285)	
1		Same as bil except for orbitor	/SIZ1#6/(286)	
2		Same as bk2 except for orbiter	/\$121 86/ (287)	
3		Same as bk3 except for orbiter	/51Z1MG/(288)	
(4		Same as bk4 except for orbitor	/\$121 N 6/(289)	
RFLG		Sizing data print flag 1. Print header 2. Print identifier 3. Print data	/S1Z1 NG /(290)	
PASS		Sizing iteration counter	/SIZING/(291)	
PSMAX		Maximum number of iterations	/\$121 86 /(292)	
EXIT		Booster engine exit area (ft==2)	/S]Z]W6/(293)	
VACD		Orbiter vacuum thrust (16)	/5121NG/(294)	
0		Number of orbiter engines	/SIZIMG/(295)	
0		Orbiter burnout weight (1b)	/\$1Z1#G/(296)	QLTOSZ O WFO
OVEL		Total ideal velocity required to orbit (fps)	/SIZING/(297)	OLTOSZ O IDVEL
5P0		Orbiter vacuum specific impulse sec	/SIZIMG/(298)	
SPB		Booster vacuum specific impulse sec	/S1214G/(299)	
PL		Payload weight (ib)	/SIZING/(300)	•
VACB		Booster vacuum thrust per engine 16	/\$1Z1W6/(301)	
NB		Number of booster engines	/5121 4 6/(302)	
0 NAV 72	6.01-47				

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FORTRAM	MATH	DESCRIPTION	STORAG	
SYMBOL	SYMBOL	DESCRIPTION	BLOCK	LOC SUBR CODE VA
₩EO		Orbiter stage meight (16)	/S121MG/(303)
WEB		Booster stage meight (16)	/SIZ1NG/(304)
WO		Initial orbiter weight (1b)	/S171NG/(305)
WLO		Booster liftoff weight (16)	/SIZING/C	306)
DVO		Orbiter ideal velocity (fps)	/S1Z1W6/(307) GLTOSZ O DVO
DAB		Booster idel velocity (fps)	/SIZING/(308)
MUB		Booster wass ratio or velocity	/SIZING/(309)
MUO		Orbiter mass ratio	/\$121NG/(310)
VSTG		Booster staging velocity (fps)	/SIZING/(311)- OLTOSZ M VSTE
MP0		Orbiter propellant weight (16)	/S1Z1NG/(312)
941		Sizing. Flag.	/SIZING/(313) QLTOSZ I JTYP Wrapup i JTYP
BECO		Booster cut-off erc	/S1Z1NG/(314)
BSTG		Booster staging arc	/\$1Z1NG/(315)
GRBI		Orbiter Ignition ere	/\$171NG/(316) QLTOSZ 1 ORBI
ITHBU		Booster empty meght curve me.	/S1Z1MG/(317)
1 THOW		Orbiter empty meight curve no.	/SIZING/(318)
SVDPSO		Saved control matric	/S12186/(319)
SVDCOM		Saved payoff improvement	/SIZING/(320)
IHUNT		Number of iterations for parameter hunt	/SIZING/(321)
SOCO		Solid engine cut-off arc	/S121NG/(326)
SOSP		Solid engine drop arc	/SIZING/(327)

BLØCK STUFF

FORTRAN Symbol	MATH Symbol	DESCRIPTION	STO	RA	GE LOC	SUBROU SUBR	COD	USAGE VAR
FK	,	An 820x4 array used to atore the vectors \mathbf{k}_1 , \mathbf{k}_2 , \mathbf{k}_3 , and \mathbf{k}_4 defined by Equations 17.6-2 thru -5 in Vol.1 of this document.	/\$TUFF	<i>n</i>	1)	MADAMS RKUTT1 RKUTT1	ı	FK
F2		Description not input	/STUFF	/(821)	MADAMS	1	F2
YP		Description not input	/STUFF	/(1641)	MADAMS	M	YP
YE		Description not imput	/STUFF	/(2461)	MADAMS	R	YC

BLØCK TABLE

FORTRAN Symbol	MATH Symbol	DESCRIPTION	S T () RA	GE LDC	SUBROU' SUBR	USAGE VAR
TABLE		A 2100 word array used for storing up to 50 splime fitted univeriant tables.	/TABLE	/(1)	SPLINE SPLINE	LOC1
LOC1		A 50 word array that corresponds to tables 1 thru 50. Each entry is an integer that points to the initial value of the independent variable of the corresponding table. A zero entry indicates table not input.	/TABLE	/(1)		
x		A 650 word array that contains the independent variable entries of all of the 50 or less tables input.	/TABLE	/(51)		
LOCL		A 50 word array that corresponds to tables 1 thru 50. Each entry is an integer that indicates the last interval in which interpolation of the corresponding table occured.	/TABLE	/(701)	SPLIME SPLIME	A FOCF
Y		A 650 word array that contains the dependent variable entries of all of the 50 or less tables input.	/TABLE	/(751)		
LOCF		A 50 word array that corresponds to tables 1 thru 50. Each entry is an integer that points to the last value of the independent variable of the corresponding table.	/TABLE	/(1401)	SPLINE SPLINE	LOCF Z
2		The mesh point second derivatives of the cubic spline functions of all of the 50 or less tables imput.	/TABLE	/(1451)		

ار بر

> BLØCK Y

FORTRAN Symbol	MATH Symbol	DESCRIPTION	S T O BLOCK		LOC	SUBROL SUBR		US AGE VAR
v		An 820 word array containing the particular and homogeneous solutions being integrated. The first 18 words comprise the particular solution. Each block of 18 words thereafter comprises an independent homogeneous solution.	/¥	,r.	1)	GROPE INARC MADAMS GLTOSI RKUTTI SALVE WRAPUF	M	4 4 4

15 60

BLØCK Z



FORTRAN Symbol	MATH Symbol	DESCRIPTION	BL	STORASI OCK	LOC	SUBROU SUBR		AR
ı	Z	A 20 mord array used to store the total linear solution from the preceding OL iteration.	/1	/(1)	BNDRYT BRANPT ENDPTQ INTERP INTERP LINDRY LI		

847

BLØCK ZD \. ?.

FORTRAN Symbol	MATH Symbol	DESCRIPTION	<u>\$</u> BL0	TORA	LOC	SUBROUT Subr C		SAGE VAR
ZO		A 20 mord array containing the vector f(X,Z,W) in Equation 17.1-7 in Vol.1 of this document.	/20	/(1)	ENVPRO LINDRY OUTPUT RKUTT2 WRAPUP	I ZD I ZO)

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558

BLØCK ZI



FORTRAN Symbol	MATH Symbol	DESCRIPTION	S 1 BLOC	gra:	GE SUBROUTINE USAGE LOC SUBR CODE VAR
ži		A 20x4 array containing the first four values of Z in the present subarc. $\dot{\ }$	/21	/(1) INTERP I ZI AKUTTI I ZI SALVE M ZI

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SUBRØUTINE. AERØCØ



Purpose

AEROCO computes either the univariant or bivariant aerodynamic coefficients ${\rm C_L}$ and ${\rm C_D}$. In addition, it computes the first and second partial derivatives

$$\frac{\partial C_L}{\partial \alpha}$$
, $\frac{\partial C_L}{\partial M}$, $\frac{\partial^2 C_L}{\partial \alpha^2}$, $\frac{\partial^2 C_L}{\partial M^2}$ and $\frac{\partial^2 C_L}{\partial M \partial \alpha}$

an d

$$\frac{\partial C_D}{\partial \alpha}$$
, $\frac{\partial C_D}{\partial M}$, $\frac{\partial^2 C_D}{\partial \alpha^2}$, $\frac{\partial^2 C_D}{\partial M^2}$ and $\frac{\partial^2 C_D}{\partial M \partial \alpha}$

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                                                                                                                                                                                                                                                                              THIS ROUTINE COMPUTES THE VEHICLE*S TOTAL LIFT AND DRAG COEFFICIENTS
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,HDMAX
,MAEC
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,XCGR
,MCND
,ARCDA(46
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, OMAX
, PHMAX
, MAEF
, MWDA
, ZE
, REMAX
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JPRO
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,JAER
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AEROCO
                                                                                                         CDM = CDOM + CL=(FKM=CL + 2,*FK+CLM)

CLAA = 0.

CDAA = 2.*FK**CLAO**2

CLAM = CLOMM + ALPHA**CLAMM

CDAM = CDOMM + 2.**CLM**(FKM**CL + FK**CLM) + CL**(FKM**CL + 2.**(FKM**CL + FK**CLM**)

**CLM + FK**CLM**)

CDAM = 2.**(FK**(CL**CLAM + CLM**CLA) + FKM**CL**CLA)

RETURM

**CLM**CL***CL***

**CLM**CL***CL***

**CLM**CL***

**CLM**CL**

**CLM**

**CLM**CL**

**CLM**

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                                                                                   50 CALL BLINE(ALPHA-DEG, MACH, CL)
CLA = CLA+DEG
CLAM = CLAM-DEG
CLAM = CLAM-DEG
CLAM = CDA+DEG
CDA = CDA+DEG
CDAM = CDA+DEG
CDAM = CDAM-DEG
CDAM = CDAM-DEG
CDAM = CDAM-DEG
CDAM = CDAM-DEG+2
RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  AERDCO
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AEROCO

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FORTRAN	MATH	COD	DESCRIPTION			DRA		SUBROUTE	NE USAGE
SYMBOL	SYMBOL		DESCRIPTION		BLOC	<u> </u>	rac	SUBR CO	DE VAR
ALPHA	œ.	1	Angle of attack .	(RAD)	/ DYNA	/(79)	AEROCO I ALGCOM M AL2 I ARCIM M CONTRL M ENVPRO I NPLANE S OUTPUT 1 TRAJIM O UT PUT 1 TRAJIM O UT PUT I MRAPUP I	ALPHA ALPHA
CD	c ^D	0	Drag coefficient		/DYNA	/(192)	AEROCO O	CD CD CD
CDA	C _D ,	R	Drag coefficient slope .	(RAD-1)	/DYNA	/(193)	AEROCO M UT I	CDA CDA
CDAA	∂C _D ,/∂α	R	Sae symbol		/DYNA	/(195)	AEROCO M ut [CDAA CDAA
CDAM	ac _D ,∕am	n	See symbol		/DYNA	/(197)	AEROCO A	CDAM CDAM
CDM	ac _D ∕am	0	See symbol		/DYNA	/(194)	AEROCO O	COM COM
CDMM	92C ^D /9W ₅	0	See symbol		/DYNA	/(196)	AEROCO O	CDMM CDMM
CDO	c _{DO}	ī	Drag coefficient at a = 0		/DYNA	/(104)	AEROCO I Statef I	CD0
CBOM	76\ ₀ 036	3	See symbol		/DYNA	/(105)	AEROCO I Statef I	CDOM
CDOMM	a ² C _{DO} /am ²	ī	See symbol		/DYNA	/(145)	AEROCO I Statef I	CDORM CDORM
CL	CL	•	Lift coefficient .		/DYNA	/(186)	AEROCO M OUTPUT I UT I	Cr Cr
CLA	c _{L*}	M	Lift coefficient slope	(RAD-l)	/DYMA	/(187)	AEROCO M Statef m ut I	CLA CLA
CLAA	3CL /3a	7	See symbol		/DYNA	/(189)	AEROCO M UT I	CLAA
CLAM	ac <mark>r"</mark> /9W	R	See symbol		/DYNA	/(AEROCO M Statef M Ut I	CLAM CLAM CLAM
CLARM	92CL / 9M2	I	See symbol		/DYNA	/(146)	AEROCO I Statef M	CLAMM CLAMM
CLM	ac_/am	n	See symbol		/DYNA	/(188)	AEROCO M UT I	CLM
CLMM	82CL/8M2	n	See symbol		/DYNA	/(190)	AEROCO M UT I	CLAM
CLO	CLO	ı	Lift coefficient at a = D		/DYNA	/(106)	AEROCO I Statef I	CLO
CLOM	ac _{Lo} /am	I	See symbol		/DYNA	/(AEROCO I Statef I	CLOM
CLOMM	$\theta^2 C_{L_0} / \theta M^2$	1	See symbol		/DYNA	/(AEROCO I Statef 1	CLOMM
FK	k	Ī	Induced drag coefficient		/BYNA	/(AEROCO I Statef I	FK FK
FKM	ak/am	1	See symbol		/DYNA	/(182)	AEROCO I Statef I	FKA FKA
FKMM	a²k/am²	I	See symbol		/DYNA	/(183)	AEROCO I Statef I	FKAA FKAA
							•		

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FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STOR BLOCK	LOC	SUBROUTIA Subr cod	
JAER		I Aerodys	amic model option flag	/ARCDAT/	(9)	AEROCO I ARCIN I OUTPUT I STATEF I UT I	JAER JAER JAER JAER JAER
MACH	M	I Mach no	aber	/DYNA /	26)	AEROCO I ENVPRO I OUTPUT I STATEF M	MACH MACH MACH MACH



SUBRØUT I NE ALGCØN

Purpose

ALGCON has two purposes. The first is to determine, by means of a Newton-Raphson iteration, a value of w, the in-plane control vector, that causes the vector of algebraic constraints

$$K = (K^{(1)}, K^{(2)}, K^{(3)})^{T}$$

to vanish. Having accomplished this, ALGCON's second purpose is to determine, by means of the implicit function theorem, the following matrices:

- i) $\partial w/\partial y$;
- ii) $\delta p/\delta y = \partial p/\partial y|_{\alpha=constant}$, if α is optimal;
- III) if α is nonoptimal $\partial(\partial w/\partial y)/\partial y_i$, i=1,2,...,8;
- iv) if α is optimal, $\frac{\partial(\delta p/\delta y)}{\partial y_i}$, i=1,2,...,8;
- v) if α is optimal, $\partial w/\partial \lambda$, where $\lambda = (\lambda_V, \lambda_Y, \lambda_{\psi})^T$;
- vi) if α is optimal, $\partial(\delta p/\delta y)/\partial \lambda_i$, i=1,2,3.*

^{*}See Sections 9, 10, 16 and 17 of Vol. I.

ALGCOM

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THIS ENTRY CONTROLS THE ITERATION FOR THE IN-PLAME CONTROL JP1, JP2 AND JP3 POINT TO THE SOVERHING EOSTROL JP1, JP2 AND JP3 POINT TO THE SOVERHING EOSTROL JP1, JP2 AND JP3 POINT TO THE SOVERHING EOSTROL JP1, JP2 AND JP3 POINT TO THE SOVERHING EOSTROL JP1, VKP12, 2), XKV3 31, XKW4(3, 9), **XKW4(3, 1), XKVY (13, 8), XKVY(13, 1), XKVX (3, 1), XKW4(3, 1), XKVX (3, 1), XKXX (3, 1), XXX (3, 1), XXX
  1.234567890112345678901122222
                                                                                                                                SUBROUTINE ALGCON(JP1, JP2, JP3)
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**XKIVD XK2VD XK3VD XK1VA XK2VA XK3VA XK1GT XK2GT XK3GT XK1GD XK2GO XK1GA XK2GA XK3GA XK1GT XK2PT XK3PT XK3PT XK1PD XK2PD XK3PD XK1PA XK2PA XK3PA XK1PT XK2PT XK3PT XK3PT XK1PD XK2PD XK3PD XK1PA XK2PA XK3PA XK1DT XK2DT XK3PT XK3PT XK3PT XK3PD XK3DD XK3DA XK1DA XK3DA XK1DT XK2UT XK3UT XK3UT XK3UD XK2DA XK3DA XK1DT XK2UT XK3UT XK3UT XK3UD XK3DA XK3DA XK1DT XK2PT XK3PT XX3UT XK3UT XX3UT XK3UT XXXUT XK3UT XXXUT XK3UT XK3UT XK3UT XK3UT XK3UT XK3UT XK3UT XK3UT XK3UT XXXUT XXXU
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                                                                            1N-PLANE CONTROL ITERATION
ASSIGN 302 TO JSMTCH
PA1 = 0.
PA2 = 0.
DO 10 1 = 1, 40
10 P(1) = 0.
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P2 = DELTAE
P3 = ALPHA
ITR = 0
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                                             123.
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125.
                                                                                        GO TO APPROPRIATE THRUST EQUATION GO TO (101, 102, 103, 104), JP1
                                                                                                                                                                                                                                                                                                                                                                         101-102-103-104-
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                                             126.
127.
                                                                         101 CALL TH1001
60 TO 110
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ALGCON
                                                                          102 CALL TH2001
60 TO 110
                                            128.
129.
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                                                                          103 CALL TH3001
60 TO 110
                                             130.
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                                                                                                                                                                                                                                                                                                                                                                        110
                                                                                                                                                                                                                                                                                                                                             JUL21
                                            132.
                                                                           104 CALL TH4001
                                                                                                                                                                                                                                                                                                                                             JUL21
                                                                                                                                           GO TO APPROPRIATE DEFLECTION EQUATION
                                                                                                                                                                                                                                                                                                                                             ALGCON
                                                                         110 GC TO (111, 112), JP2
                                                                                                                                                                                                                                                                                                                                            ALGCON
                                                                                                                                                                                                                                                                                                                                                                       1111-
                                             134.
                                                                         111 CALL DL1001
60 TO 120
                                             135.
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                                             136.
                                                                                                                                                                                                                                                                                                                                            ALGCON
                                             137.
                                                                         112 CALL DL2001
                                                                                                                                                                                                                                                                                                                                            ALGCOM
                                                                                                                                           GO TO APPROPRIATE ANGLE OF ATTACK EQUATION
                                             138.
                                                                                                                                                                                                                                                                                                                                            ALGCON
                                                                         120 GO TO (122, 123, 124, 125, 126, 127, 128, 129), IP3
                                                                                                                                                                                                                                                                                                                                                                        122-7123-7
                                            139.
                                                                                                                                                                                                                                                                                                                                            ALGCON
                                            140.
                                                                           122 CALL AL2001
60 TO 300
                                                                                                                                                                                                                                                                                                                                            ALGCON
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            300-
                                                                                                                                                                                                                                                                                                                                             ALGCON
                                                                         123 CALL AL3001
60 TO 300
                                           142.
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                                           144.
                                                                         124 CALL AL4001
60 TO 300
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                                                                                                                                                                                                                                                                                                                                             AL GCGM
6 'BCT 72 6.01-44
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	1111
1	
146. 125 CALL AL5001 147. GO TO 300	ALGCON 300
148. 126 CALL AL6001	ALGCON
149. 60 TO 300	ALGCON 300-
150 127 CALL AL7001 151. GO TO 300	ALGCON 300-
152. 128 CALL AL8001 153. GO TO 300	ALGCON 300-
154. 129 CALL AL9001	ALGCON
155. GO TO 300 156. C OPTIMAL ANGLE OF ATTACK	ALGCON 300
157. 199 ASSIGN 200 TO ISWTCH 158. 200 CALL UTOP	ALGCON -
159. C GO TO APPROPRIATE THRUST EQUATION (160. GO TO (20), 202, 203, 204), JP1	ALSCON JUL21 201-7202-7203-7264-7
161. 201 CALL TH1002	ALGCON
162. 60 TO 210	ALGCON 210-
163. 202 CALL TH2002 164. GO TO 210	ALGCON 210-
165. 203 CALL TH3002 166. GO TO 210	ALGCON Jul 21 210
167. 204 CALL TH4002	JUL21
168. C GO TO APPROPRIATE DEFLECTION EQUATION 169. 210 GO TO (211, 212), JP2	ALGCON 211 212
170. 211 CALL DL1002	ALGCON
171. GO TO 220	ALGCON 220-
172. 212 CALL DL2002 173. C GO TO OPTIMAL ANGLE OF ATTACK EQUATION	ALGCON .
174. 220 CALL AL1001	ALGCON
175. 300 ITR = ITR + 1 176. C TEST FOR TOO MANY ITERATIONS	ALGCON ALGCON
177. 1F(1TA .GT. 20) CALL ERADR(XALGEN, -1, 0)	ALGCON
178. 301 CONTINUE. 179. C COMPUTE INVERSE OF PARTIALS MATRIX	ALGCON ALGCON
180. DET = xx2T+(xx1D+xx3a - xx1a+xx3D) + xx2D+(xx1a+xx3T - xx1T+xx3a) 181. + xx2a+(xx1T+xx3D - xx1D+xx3T)	ALGCOM !
182. C TEST FOR SINGULARITY 183. IF(ABS(DET) .LT. 1.E-14) CALL ERROR(XALGCM, -2, 0)	ALSCON ALGCON
1184. XKPI11 = (XK2D+XK3A - XK2A+XK3D)/DET 1185. XKPI21 = (XK2A+XK3T - XK2T+XK3A)/DET	ALGCON
186. XKP131 = (XK2T+XK3D - XK2D+XK3T)/OET 187. XKP112 = (XK1A+XK3D - XK1D+XK3A)/OET	ALGCON ALGCON
188. XKP122 = (XK1T+XK3A - XK1A+XK3T)/OET 189. XKP132 = (XK1D+XK3T - XK1T+XK3D)/DET	ALGCOM ALGCOM
190. XKP113 = (XK10+XK2A - XK1A+XK2D)/DET 191. XKP123 = (XK1A+XK2T - XK1T+XK2A)/DET	ALGCON ALGCON
192. XKP133 = (XK1T+XK2D - XK10+XK2T)/DET 193. GO TO JSWTCH	ALGCOM ALGCOM
1194. C COMPUTE INCREMENT FOR IN PLANE CONTROL	ALGCON
1196. C CHECK FOR CONVERGENCE	ALGCON ALGCON
197. SUM = 0. 198. DD 306 1 = 1, 3	ALGCON ALGCON
199. DIV = P(I) 200. IF(DIV .EQ. O.) DIV = 1.	ALGCOM .
-201. 306 SUM = SUM + ABS(DP(1)/DIV) 202. IF(SUM .LE. 1.E-12) 60 TO 307	ALGCOM 307-
203. C NOT CONVERGED VET 204. CALL MATADD(P, P, DP, 3, 1)	ALGCON ALGCON
205. T = P1 206. DELTAE = P2	ALGCON ALGCON
207. ALPHA = P3 208. 60 TO ISMICH	ALGCON ALGCON
N	
209. C CONVERGED	ALGCON

```
ALGCOM
                                               213.
214.
215.
216.
217.
218.
219.
220.
221.
222.
223.
224.
225.
226.
                                                                                                ALPHA = P3
                                                                                                 RETURN
                                                                                                                                                     THIS ENTRY COMBINES UP THE FIRST AND SECOND PARTIALS OF THE IN PLANE CONTROL WITH RESPECT TO THE STATE AND COSTATE
                                                                              ENTRY ALGCRY
ASSIGN 500 TO JSMTCM
DO 399 1 = 4,549
399 P(I) = 0.
400 CALL UT
                                                                      C
                                                                                               GO TO APPROPRIATE THRUST EQUATION GO TO (401, 402, 403, 404), JP1
                                                                                                                                                                                                                                                                                                                                                                     ALGCOM
                                                                                                                                                                                                                                                                                                                                                                      JUL21
                                                                                                                                                                                                                                                                                                                                                                                                    401-1402-1403-
                                                                               401 CALL THI
60 TO 410
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                               227.
228.
                                                                                                                                                                                                                                                                                                                                                                                                    410-
                                                                                402 CALL TH2
60 TO 410
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                                                                                                                                                                                                                                                                                                                                                                                     410-
                                               230.
                                               231.
232.
                                                                               403 CALL TH3
60 TO 410
                                                                                                                                                                                                                                                                                                                                                                     AL GCON
                                                                                                                                                                                                                                                                                                                                                                      JUL21
                                                                                                                                                                                                                                                                                                                                                                                                    410
                                                233.
                                                                                404 CALL TH4
                                                                                                                                                                                                                                                                                                                                                                    JUL21
ALGCOM
                                                                                                                                                     60 TO AFPROPRIATE DEFLECTION EQUATION
                                               235.
                                                                               410 GO TO (411, 412), JP2
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
                                                                                                                                                                                                                                                                                                                                                                                                   411-
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                               236.
237.
                                                                              411 CALL DL1
60 TO 420
                                                                                                                                                                                                                                                                                                                                                                                                   420-
                                               238.
239.
                                                                                                                                                                                                                                                                                                                                                                    ALECON
ALECON
                                                                                412 CALL DL2
                                                                                                                                                     GO TO APPROPRIATE ANGLE OF ATTACK EQUATION
                                                                                                                                                                                                                                                                                                                                                                    ALGCON 421-
                                                240.
                                                                                420 60 TO(421, 422, 423, 424, 425, 426, 427, 428, 429), JP3
                                                                                                                                                                                                                                                                                                                                                                                                                         422-
                                                                                                                                                                                                                                                                                                                                                                                                                                            423-
                                                                                                                                                                                                                                                                                                                                                                                                                                                               424-
                                                                               421 CALL AL1
60 TO 450
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                               241.
242.
                                                                                                                                                                                                                                                                                                                                                                                                    450
                                                243.
244.
                                                                                             CALL AL2
60 TO 450
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                                                               423 CALL AL3
60 TO 450
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                                 245.
                                                                                                                                                                                                                                                                                                                                                                                                    450-
                                                 246
                                               247.
248.
                                                                               424 CALL AL4
60 TO 450
                                                                                                                                                                                                                                                                                                                                                                     ALGCOM
                                                                                                                                                                                                                                                                                                                                                                                                    450-
                                                                                                                                                                                                                                                                                                                                                                     ALGCON
                                                249.
250
                                                                               425 CALL ALS
GO TO 450
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                                                                                                                                                    .
                                                                                                                                                                                                                                                                                                                                                                                                    450
                                                                               426 CALL AL6
GO TO 450
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                                251.
252.
                                                                                                                                                                                                                                                                                                                                                                                                    450
                                                                               427 CALL AL7
60 TO 450
                                                                                                                                                                                                                                                                                                                                                                    ALGCOM
ALGCOM
                                                 253.
                                                                                                                                                                                                                                                                                                                                                                                                   450-
                                                 254.
                                               255.
256.
                                                                               428 CALL AL8
60 TO 450
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                                                            TEST FOR OPTIMAL OR NONOPTIMAL ANGLE OF ATTACK

OPTIMAL. COMPUTE PARTIALS OF THRUST AND DEFL.

RESPECT TO STATE AS THOUGH ALPHA WERE COMSTANT.

YKP111 = XK2D/DET

YKP121 = XK2T/DET

YKP122 = XK1T/DET

OR THE STATE AS THOUGH ALPHA WERE COMSTANT.
                                                                                                                                                                                                                                                                                                                                                                    ALGCON
                                               257.
                                                                                                                                                                                                                                                                                                                                                                   ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
                                              258.
259.
261.
262.
263.
264.
265.
2667.
268.
269.
                                                                      C
                                                                                                                                                                                                                                                                                                                                                                                                 1504
                                                                       C
                                                                                                                                                                                                                                                                                                                                                                   ALGCONN
ALGCON
                                                                             YRP112 = XK10/DEY
YKP122 = XK17/DEY
DD 503 1 = 1, 2
DD 502 J = 1, 8
SUM = 0.
DD 501 K = 1, 2
501 SUM = SUM + YKP1(1, K)*XKY(K, J)
502 DEPDEY(1, J) = SUM
503 CONTINUE
                                              270.
271.
272.
273.
274.
275.
276.
277.
                                     9
                                                                      C
                                                                                                                                                     IF OL IS CONVERGED WE ARE DOME.
                                                                                              IF WE IS CONVENDED.

IF(KONVER) RETURN
NONOPTIMAL OR OPTIMAL AND QL NOT CONVERGED.

TOTAL FIRST PARTIALS OF IN PLANE CONTROL WITH
                                                                      C
6 DCT 72 6.01-44
```

```
RESPECT TO STATE.
       279.
                                                                                                                                                                                                                                                                      ALGCON
     286. C
281. C
282. C
283. C
284. 285. C
286. C
                                 504 CALL MATMLT(DPDY, XKPII), XKIV, 3, 3, 8)
IF OL IS CONVERGED WE ARE DOME.
                                                                                                                                                                                                                                                                      ALGCON
                                                                                                                                                                                                                                                                      ALGCON
                                              IF OL IS CONVERGED WE ARE DOME.

IF(KONVER) RETURN

TEST FOR OPTIMAL OR NONOPTIMAL ANGLE OF ATTACK

IF(JP3 .EQ. 1) GO TO 517

NONOPTIMAL. COMPUTE TOTAL SECOND PARTIALS OF IN-
PLANE CONTROL WITH RESPECT TO STATE. RESULTS GO IN
ARRAY PRODS.
                                                                                                                                                                                                                                                                     ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
                                                                                                                                                                                                                                                                      ALGCON
ALGCON
                                              KP = 0

KLIM = 0

INC = 3

DU 509 K = 1, 3

KLIM = KLIM + INC

INK = 3

KK = K
        288.
       289.
290.
291.
                                                                                                                                                                                                                                                                      ALGCON
ALGCON
ALGCON
     292.
293.
294.
                                                                                                                                                                                                                                                                      ALGCON
ALGCON
                                                                                                                                                                                                                                                                      JUL21
                             5041 KP = KP + 1

00 505 1 = 1, 3

505 5KHM(1, KP) = XKHM(1, KK)

1F(1NK + K - 4) 506, 506,
     295.
                                                                                                                                                                                                                                                                      JUL21
       296.
297.
298.
                                                                                                                                                                                                                                                                      ALGCON
ALGCON
ALGCON
     299.
300.
                                506 INK = 1
GO TO 508
                                                                                                                                                                                                                                                                     ALGCOM
                                                                                                                                                                                                                                                                                           508-
                                                                                                                                                                                                                                                                      ALGCON
      301.
                                507 INK = INK - 1
                                                                                                                                                                                                                                                                     ALGCOM
                                507 INK = INK - 1

508 KK = KK + INK

IF(KK LE. KLIM) GO TO 5041

509 INC = INC - 1

III = -7

II = -2

JLIM = 0

INC = 8

90 516 J = 1 8

III = III + 8

II = II + 3

JLIM = JLIM + INC

IMK = B

J = 0

JJ = 1
      302.
303.
304.
                                                                                                                                                                                                                                                                     JUL21
JUL21
                                                                                                                                                                                                                                                                                              5041
                                                                                                                                                                                                                                                                    ALGCON
       305.
      307.
307.
308.
    308.
309.
310.
311.
312.
313.
314.
315.
                             5091 J = J + 1

00 510 K = 1, 3

510 SKYYI(K, J) = KKYY(K, JJ)

IF(INK + I - 9) 511, 511,
216.
317.
318.
319.
                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                                                                                                                                                                                                                                                      ALGCON
     320.
321.
                                511 INK = 1
60 TO 513
                                                                                                                                                                                                                                                                    ALGCON
ALGCON
                                                                                                                                                                                                                                                                    ALGCON
     322.
                              512 INK = IMK - 1

513 JJ = JJ + JMK

IF(JJ LE. JLIM) 60 TO 5091

JJ = -2

DO 514 J = 1, 8

JJ = JJ + 3

514 CALL MATMLT(YY(1, J), XKMY(1, JJ), DPDY(1, I), 3, 3, 1)

CALL MATMLD(SKYYI, SKYYI, YY, 3, 8)

KK = -2

DO 515 K = 1, 3

KK = KK + 3

515 CALL MATMLT(ZZ(1, K), SKMM(1, KK), DPDY(1, I), 3, 3, 1)

CALL MATMLT(ZZ(1, K), SKMM(1, KK), DPDY(1, I), 3, 3, 1)

CALL MATMLT(YY, ZZ, DPDY, 3, 3, 8)

CALL MATMLT(YY, ZZ, DPDY, 3, 3, 8)

CALL MATMLT(PRODS(1, III), XKPII1, SKYYI, 3, 3, 8)

516 INC = INC - 1

RETURN

OPTIMAL. COMPUTE TOTAL FIRST PARTIALS OF
                                512 INK = INK - 1
323.
324.
325.
326.
327.
328.
                                                                                                                                                                                                                                                                    JUL21
JUL21
ALGCOM
                                                                                                                                                                                                                                                                    ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
     329.
330.
331.
    331.
332.
333.
334.
335.
336.
337.
338.
339.
340.
                                                                                                                                                                                                                                                                    ALGCOM
                                                                                                                                                                                                                                                                    ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
                                                                                                                                                                                                                                                                    ALGCOM
                                                                                          OPTIMAL. COMPUTE TOTAL FIRST PARTIALS OF IN PLANE CONTROL WITH RESPECT TO COSTATE.
                                                                                                                                                                                                                                                                    ALGCOM
ALGCOM
                             517 XKL31 = VDA

XKL32 = GDA

XKL33 = PDA

CALL MATMLT(DPDL, XKPI11, XKL11, 3, 3, 3)

COMPUTE TOTAL FIRST PARTIALS OF THE MATRIX DEPDEY

WITH RESPECT TO THE STATE. DEPDEY WAS COMPUTED

ABOVE. RESULTS GO IN ARRAY PROD1.
    342.
343.
344.
345.
346.
348.
                                                                                                                                                                                                                                                                    ALGCON
                                                                                                                                                                                                                                                                    ALGCOM
                                                                                                                                                                                                                                                                    ALGCON
ALGCON
ALGCON
                                                                                                                                                                                                                                                                    AL GCOM
```

```
349.
350.
351.
352.
353.
354.
355.
                                                                                     KP = 0
KLIM = 0
IMC = 3
DO 522 K = 1, 2
KLIM = KLIM + IMC
IMK = 3
KM = K
                                                                                                                                                                                                                                                                                                                             ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
JUL21
                                       356.
357.
358.
359.
                                                                     5171 KP = KP + 1

00 518 I = 1, 2

518 SLWY(I, KP) = XKWW(I, KK)

IF(INK + K - 4) 519, 519,
                                                                                                                                                                                                                                                                                                                             JUL21
                                                                                                                                                                                                                                                                                                                            ALGCON S19 520
                                           360.
361.
                                                                        519 INK = 1
60 TO 521
                                                                                                                                                                                                                                                                                                                             ALGCON
ALGCON
                                           362.
                                                                       520 INK = INK - 1
                                                                                                                                                                                                                                                                                                                            ALGCON
                                                                   520 INK = INK - 1

521 KK = KK + INK
IF(KK LE. KLIM) GO TO 5171

522 INC = INC - 1

11 = -7

DO 524 I = 1, 3

II = II + 8

JJ = -2

DO 5223 J = 1, 8

JJ = JJ + 3

DO 5222 K = 1, 2

JJJ = JJ

SUM = 0.

DO 5221 L = 1, 3

SUM = SUM + IKWY(K, JJJ)+DPOL(L, I)

5221 JJJ = JJJ + IKWY(K, JJJ)+DPOL(L, I)

5222 VY(K, J) = SUM

5223 CONTINUE

KK = -2

DO 523 K = 1 2
                                           363.
364.
365.
366.
367.
369.
370.
371.
372.
                                                                                                                                                                                                                                                                                                                             JUL21
                                                                                                                                                                                                                                                                                                                            JULZI
ALGCON
ALGCON
ALGCON
ALGCON
                                                                                                                                                                                                                                                                                                                             ALGCON
ALGCON
ALGCON
                                     374.
375.
376.
377.
                                                                                                                                                                                                                                                                                                                            ALGCON
ALGCON
ALGCON
                                                                                                                                                                                                                                                                                                                           ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
                                   378
379
389
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382
383
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387
386
391
392
391
392
393
394
395
396
                                                                     5223 CONTINUE

KK = -2

00 523 K = 1, 2

KK = KK + 3

523 CALL MATMLT( UU(), K), SLWY(1, KK), OPDL(1, 1), 2, 3, 1)

CALL MATMLT(SLYLI, UU, DEPDEY, 2, 2, 8)

CALL MATMLT(PROD9(1, SLYLI, VV, 2, 8)

524 CALL MATMLT(PROD9(1, II), YKPI, SLYLI, 2, 2, 8)

III = -7

III = -7

III = -7

III = -2

JIN = 0

INC = 8

00 535 I = 1, 8

III = III + 3

JLIM = JLIM + INC

INK = 8

J = 0

JJ = 1

5241 J = J + 1
                                                                                                                                                                                                                                                                                                                           ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
ALGCON
                                                                                                                                                                                                                                                                                                                             ALGCOM
                                                                                                                                                                                                                                                                                                                            ALGCON
ALGCON
ALGCON
                                                                                                                                                                                                                                                                                                                            JUL21
                                                                   5241 J = J + 1

00 525 K = 1, 2

525 SLYY[(K, J) = #KYY(K, JJ)

1F(1MK + 1 - 9) 526, 526, 527
                                    398.
399.
400.
401.
                                                                                                                                                                                                                                                                                                                           JUL21
ALGCOM
                                                                                                                                                                                                                                                                                                                           ALGCON
ALGCON
                                                                                                                                                                                                                                                                                                                                                     526 527
                                                                     526 INK = 1
60 TO 528
                                         402.
403.
404.
                                                                                                                                                                                                                                                                                                                           ALGCON
                                                                                                                                                                                                                                                                                                                           ALGCON 528
                                                                    527 INK = INK - 1
                                                                                                                                                                                                                                                                                                                           ALGCOM
                                                                                                                                                                                                                                                                                                                          JUL21
JUL21
ALGCON
                                         405.
406.
407.
408.
409.
410.
411.
412.
413.
                                                                                                                                                                                                                                                                                                                                                      5241
6 OCT 72 6.01-44
```

```
420. DO 532 K = 1, 2
421. KK = KK + 3
422. 532 CALL MATALT(UU(1, K), SLWV(1, KK), DPDV(1, I), 2, 3, 1)
423. DO 534 K = 1, 2
424. JJ = II
425. DO 533 J = 1, 2
426. UU(K, J) = UU(K, J) + XKWY(K, JJ)
427. 533 JJ = JJ + 1
428. 534 CONTINUE
429. CALL MATALT(VV, UU, DEPDEY, 2, 2, 8)
430. CALL MATALT(VV, UU, DEPDEY, 2, 2, 8)
431. CALL MATALT(PRODI(1, III), VKPI, SLYVI, 2, 2, 8)
432. 535 INC = INC - 1
433. RETURM
434. END
```

FORTRAN Symbol	MATH Symbol	CODI	DESCRIPTION	DESCRIPTION					DE VAR
ALPHA	α		Angle of attack	(RAD)	/DYNA	/(79)	AEROCO ALGCON I AL2 I ARCIN I CONTRL I ENVPRO MOMECO MPLANE OUTPUT TRAJIN I UT	A LPHA ALPHA
DELTAE	€ _E	R	Engine deflection (1	RADS)	/DYNA	/(155)	ALGCON FARCIN FOR CONTRL FOR CONTRL FOR CONTRL FOR CONTRUCT TO TRAJIN OUT	DELTA DELTA DELTA DELTA DELTA DELTA
DEPDEY	δρ/δγ	M	A 2x8 matrix that contains $\delta p/\delta y = \partial p/\partial y \Big _{\bf a} = {\sf constant}$		/MATS	/(285)	ALGCON P	DEPDE
DPDL	∂#/∂X	1	A 3x3 matrix that contains $\partial \sigma/\partial \lambda_y$, $\partial \sigma/\partial \lambda_y$ and $\partial u/\partial \lambda_y$		/MATS	/(301)	ALGCON I	
DPDY	∂ m /∂y	3	A 3x8 matrix that contains the total first parderivatives of the in-plane-control vector art OL state.	tial the	/MATS	/(261)	ALGCON I	DPDY
6DA	K(3)	1	Explicit partial of K(3) art λ_y when α is optimized in	el.	/MATS	/(17)	ALGCON I	GDA GDA
KONYER		1	Logical flag that indicates to the 9L module to the GL iteration is converged.	far	/CNTRL	/(28)	ALGCON I APPLY I ARCIM I COHDMO GROPE O MLDRY I OUTPUT I RKUTTI I	KONAEI KONAEI KONAEI
P		m	First entry of 3 word in-plane control vector (•	/MATS	/(1)	ALGCON F	
PAL		0	Not used		/RATS	/(259)	ALGCOM O	PAI
PA2		Đ	-x(2)/x(2)		/MATS	/(260)	ALGCON O	
PDA	رر (3)	1	Explicit partial of K ⁽³⁾ art λ_{ϕ} shen a is option	al.	/MATS	/(18)	ALGCON I	PDA PDA
PR001	3(6p/6y)/3y	I	A 2x64 matrix that contains the dotal first partials of the matrix DEPDEY art the GL state.		/MATS	/(310)	ALGCON I ALGCON I APPLY I APPLY I	PRODI
PAOD5	∂(δρ/δ γ)/∂γ	1	A 2x64 matrix that contains the total first partials of the matrix DEPDEY art the GL state.		/MATS	/(310)	ALGCON I ALGCON I APPLY I APPLY I	PRODI PRODI PRODI PRODI
PROD9		1	A 2x64 matrix that contains $\partial(\delta p/\delta y)/\partial \lambda_y$, $\partial(\delta p/\delta y)/\partial \lambda_y$ and $\partial(\delta p/\delta y)/\partial \lambda_y$		/MATS	/(502)	ALGCON I	PROD9
Pl		m	First entry of 3 gord in-plane control vector a	•	/MATS	/(1)	ALGCON P	P
SKWW		w	A 3x9 array that contains Kmm		/ALGCOM	/(+)	ALGCON W	S K WW
SKYYI		M	A 3x8 array that contains Kyy;		/ALSCON	/(=)	ALGCON M	SKYYI
SLWY		•	A 2x6 array that contains Lmp, where $L = (R^{(1)}, K^{(2)})^{\frac{1}{2}}$		/ALGCOM	/(+)	ALGCON W	STMA
SLYLI		1	A 2x8 array that contains Lyh;		/ALGCOM	/(+	,	ALGCON I	SLYLI
SLYYI		W	A 2x8 array that contains Lyy;		/ALGCOM	/(+)	ALGCON W	SLYYI

FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION	-	STORA	LOC	SUBROUTINE SUBR CODE		
				LUCK		-	-	
ī	τ	M Thrust (L85) /D	YNA /(42)	ALGCON AL1 AL4 AL6 AL7 AL8 AL9 APPLY CONTRL DL2 IMPULS OUTPUT TH1 TH2 TH3 TH4	I I I I I I I I I I I I I I I I I I I	T T T T T T T T T T T T T T T T T T T
VDA	κ ^{γ*} (3)	I Explicit partial of K ⁽³⁾ art λ_y when α is optim	al. /A	ATS /C	16)	ALSCON AL1	1 0	VDA VDA
XKL11	•	C. The first word in a 3x3 array that contains $\kappa_{\lambda_{\psi}}$ and $\kappa_{\lambda_{\psi}}$, /A	-6CON/(-)	ALGCON	C	XKL11
XKPI11		M The first entry in the 3x3 matrix -K-1	/6	ATS /C	250)	ALGCOM	n	KKP111
XKWM	K(1)	1 First entry in 3x6 matrix containing K _{mm}	/#	ATS /(23)	ALGCON TH3		XKWW XK17T
XKWY	K(1)	I The first entry in a 3x3 matrix containing K _{vp}	/#	ATS /(70)	ALGCON TH3		XKJAL XKMA
XKY	K €13	I The first entry in a 3x8 matrix containing Ky	/ fi	NTS /(46)	ALGCON ALGCON TH3 TH4	I	XK14 XK14 XK14 XK4
XKYY	K(1)	I The first entry in a 3x8 matrix containing K _y ,	/ PI	ATS /(142)	ALGCON TH3 TH4	R	XK J A A XX J A A XK A A
XK1		I First entry of 3 word in-plane control constrain K .	nts /A/	its /(4)	ALGCON THROTL TH1 TH2 TH3 TH4	I 0 0	XK1 XK1 XK1 XK1 XK1 XK1
XK1T	K(1)	I First entry of 3x3 matrix containing the explici partials of K mith respect to m, K _m	it /#/	it\$ /(7)	ALGCON TH1 TH2 TH3	0	XK1T XK1T XK1T XK1T
XKIV	K (1)	I The first entry in a 3x8 matrix containing $K_{f y}$	/ M/	175 /(46)	ALGCON ALGCON TH3 TH4	I I	XK]A XK]A XK]A XKA
YKPI		I A 2x2 array that contains -[L _p]-1	/AL	.6C0N/(•)	ALGCON	-	YKPI

SUBRØUT I NE AL 1

Purpose

ALl evaluates the optimal angle of attack constraint, Equation 16.8-3 in Vol. I. In addition, it computes the explicit first partials of this constraint with respect to the state, costate and in-plane control as they are needed.

```
SUBROUTINE ALL
AL1
AL1
AL1
AL1
AL1
DD
                                          THIS ROUTINE APPLYS WHEN THE ANGLE OF ATTACK IS OPTIMAL. THIS ENTRY COMPUTES THE EXPICIT PARTIALS OF THE CONSTRAINING EQUATION WITH RESPECT TO THE STATE, COSTATE AND IN-PLANE CONTROL.
               JUL21
                                                                                                                                DYMA
                                                                                                                                DYMA
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93. C
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                                                                                                                                                                     THIS ENTRY COMPUTES THE FIRST PARTIALS WITH RESPECT TO IN-PLANE CONTROL.
                                                                             ENTRY AL1001
ASSIGN 1002 TO LABL1
GO TO 1000
                                                                            GO TO 1000

THIS ENTRY EVALUATES THE CONSTRAINING EQ. ONLY.

ENTRY AL1000
ASSIGN 1003 TO LABL1
INITIALIZATION FOR ALL ENTRIES.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           1000
       98. C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        AL1
AL1
                               ENTRY ALIDOO

ASSIGN 1003 TO LABL1

C

INITIALIZATION FOR ALL ENTRIES.

1000 VLV = V*LV

XLTOT = LGAR*COSPHI + LPSI*SINPHI/COSGAM
XDEL = T*SIDAE
YDEL = T*CODAE
PA2 = -XK2A/KK2D
OMPA2 = 1. PA2
DIDA = -XDEL*OPA2 + DB*SINA - DRAGA
DYDA = -YDEL*OPA2 + DB*SINA - DRAGA
DYDA = -YDEL*OPA2 + DB*SINA - DRAGA
DYDA = -YDEL*OPA2 - DB*COSA + LIFTA
C

1001 DPA2 = (XK2VA + XK2VD*PA2)/XK2D
ODX = -XDEL*OPA2 + DB*SINA - DRAGA*
ODY = -YDEL*OPA2 + DRAGVA

ODY = -YDEL*OPA2 + LIFTVA
XK3Y = LV*(DXDA + V*DDX) + XLTO*DDY
XK3G = DVDA*PSI*SIAPHI*SINGAM/CDSGAM*2

DDX = -XDEL*OPA2 + DBR*SINA - DRAGRA
DDY = -YDEL*OPA2 + LIFTMA
XK3R = VLV*ODX + XLTOT*ODY
VDA = XXZAA + XKZAB*PA2//XK2D
DDX = -XDEL*OPA2
DDX = -XDEL*OPA2
DDX = -XDEL*OPA2
DDX = SINPHI/CDSGAM*DYDA
COMPUTE PARTIALS #:TH RESPECT TO IN-PLANE CONTROL.

1002 DPA2 = (XK2TA + XKZTD*PA2)/XK2D
DDX = -SDAE*OMPA2 - XDEL*OPA2
DDY = CODAE*OMPA2 - XDEL*OPA2
DDY = CODAE*OMPA2 - XDEL*OPA2
DDY = XDEL*OMPA2 - XDEL*DPA2
DDY = XDEL*OMPA2 - XDEL*DPA2 + DB*SINA + LIFTMA
XK3D = VLV*DDX + XLTOT*DDY
DPA2 = (XKZAA + XKZDD*PA2)/XKZD
DDX = XDEL*DMPA2 - XDEL*DPA2 + DB*SINA + LIFTMA
XK3D = VLV*DDX + XLTOT*DDY

PAS = (XKZAA + XKZDD*PA2)/XKZD
DDX = XDEL*DMPA2 - XDEL*DPA2 + DB*SINA + LIFTMA
XK3D = VLV*DDX + XLTOT*DDY

RETURN
END
 100.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        AL1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       AL1
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                                                                           RETURN
END
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FORTRAN Symbol	MATH Symbol	CODE	STORAL BLOCK		SAGE	
CODAE	cos(α-6 _E)	I See symbol		/DYNA /(151) AL1 I COD AL4 J COD AL6 I COD AL7 I COD AL8 I COD AL9 I COD APPLY I COD CONTAL J COD MLORV I COD TM3 I COD UT D COD	DAE DAE DAE DAE DAE DAE DAE DAE
COSA	C 0 8 04	1 See symbol		/BYNA /(10) AL1 I COS AL4 I COS AL6 I COS AL7 I COS AL8 I COS AL9 I COS APPLY I COS CONTRL I COS NLORV I COS OUTPUT I COS TH3 I COS UT M COS UT M COS	5 A 5 A 5 A 5 A 5 A 5 A 5 A
COSGAR	C 0 8 7	I See symbol	· · •	/DYNA /(4) AL1 I COS AL4 I COS AL7 I COS ALB I COS	GAM GAM GAM GAM GAM GAM GAM
COSPHI	cos∲	i See symbol		/BYMA /(93) ALI I COSI AL4 I COSI APPLY I COSI ARCIN O COSI CONTRL M COSI OUTPUT I COSI	PHI PHI PHI PHI
DB	D _b	I Base drag	(LBS)	/DYNA /(163) ALI I DB AL4 I DB AL6 I DB AL7 I DB AL7 I DB AL9 I DB APPLY I DB COMTRL I DB MLORY I DB STATEF I DB TH3 I DB	
DBR .	∂D _b /∂R	1 See symbol		/DYNA /(86) ALI I DBR ALY J DBR AL6 I DBR AL7 I DBR AL8 I DBR AL9 I DBR APPLY I DBR STATEF I DBR TH3 I DBR UY I DBR	
DRAGA	∂D/∂¤	1 See symbol	······································	/DYNA /(72) ALI I DRAG AL5 I DRAG AL7 I DRAG AL8 I DRAG AL9 I DRAG APPLY I DRAG TH3 I DRAG UT M DRAG	ga ga ga ga ga

FORTRAN Symbol	MATH Symbol	COOE DESCRIPTION	BLOC	TORA!	LOC	SUBROU SUBR	CODE	E USAGE E VAR
DRAGAA	∂ ² D/∂α ²	I See symbol	/DYNA	/(78)	AL1 AL5 AL7 AL8 AL9 APPLY TH3	I I I I I	DRAGAA DRAGAA DRAGAA DRAGAA DRAGAA DRAGAA DRAGAA
DRAGRA	∂ ² D/∂R∂α	1 See symbol .	/DYNA	76	77)	AL1 AL5 AL7 AL8 AL9 APPLY TH3 UT	I I I I I	DRAGRA DRAGRA DRAGRA DRAGRA DRAGRA DRAGRA DRAGRA DRAGRA
DRAGVA	∂ ² D/∂V∂∝	I See symbol .	/DYNA	/(75)	AL1 AL5 AL7 ALB AL9 APPLY TH3 UT	1 1 1 1 1 1	DRAGVA DRAGVA DRAGVA DRAGVA DRAGVA DRAGVA DRAGVA
GDA _.	K(3)	0 Explicit partial of $K^{(3)}$ art λ_p shen a is optimal.	/MATS	/(17)	ALGCON AL1	1 0	GDA GDA
LGAM	λ,	I Relative flight path angle costate	/0	/(101)	AL1 ARCIN CONTRL NLDRV OUTPUT WRAPUP	1 1	LGAM LGAM LGAM LGAM LGAM LGAM
LIFTA	∂L/∂α	I See symbol	/DYNA	/(63)	AL1 AL4 AL5 AL6 APPLY TH3 UT	I I I I	LIFTA LIFTA LIFTA LIFTA LIFTA LIFTA
LIFTAA	∂ ² L/∂œ ²	I See symbol .	/DYNA	/(144)	AL1 AL4 AL5 AL6 APPLY TH3 UT	I I I I	LIFTAA LIFTAA LIFTAA LIFTAA LIFTAA LIFTAA
LIFTMA	∂ ² L/∂m∂ a	I See symbol	/DYNA	/(85)	AL1 AL4 AL5 AL6 APPLY TH3 UT	1 1 1 1	LIFTMA LIFTMA LIFTMA LIFTMA LIFTMA LIFTMA
LIFTRA	∂ ² L/∂R∂ œ	I See symbol	/DYNA	/(68)	AL1 AL4 AL5 AL6 APPLY TH3 UT	I I I I I	LIFTRA LIFTRA LIFTRA LIFTRA LIFTRA LIFTRA LIFTRA
LIFTVA	∂ ² L/∂V∂¤	I See symbol	/DYNA	/(AL1 AL4 AL5 AL6 APPLY TH3 UT	I I I I I	LIFTVA LIFTVA LIFTVA LIFTVA LIFTVA LIFTVA

ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	SIORAGE BLOCK LO			SUBROUTINE USA SUBR CODE VA		
LPS1	λ_{ullet}	I	Relative azimuth angle costate	/D	/(102)	ALI ARCIN CONTRL NLORY OUTPUT WRAPUP	I LPSI I LPSI I LPSI	
LV	λ,	1	Relative velocity costate	/0	/(100)	ALI CONTRL : NLDRY : OUTPUT : WRAPUP :	I LV	
PA2		Ħ	-K(2)/K(2)	/MATS	/(260)	ALGCON (D PA2 M PA2	
PDA	K(3)	0	Explicit partial of K ⁽³⁾ art λ_{μ} when α is optimal.	/MATS	/(18)	ALGCON I	I PDA D PDA	
SIDAE	sin(α-6 _E)	1	See symbol	/DYNA	/(152)	AL4 AL6 AL7 AL8 AL9 APPLY CONTRL TH3	SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE	
SIMA	sinα	1	See symbol	, /DYNA	/(9)	AL7 AL8 AL9 APPLY CONTRL OUTPUT TH3	I SIMA	
SINGAM	sin 7	ı	See symbol .	/DYNA	/(3)	ALI AL4 AL7 AL8 AL9 CONTRL I NLDRV I PDBCOL I STATEF	SINGAI SINGAI SINGAI SINGAI SINGAI SINGAI	
SIMPHI	sin≠	1	See symbol	/DYNA	/(92)	AL1 1 AL4 1 APPLY 1 CONTRL 5 OUTPUT 1	I SINPH I SINPH M SINPH	
ī	τ.		Thrust (LBS)	/ DY NA	/(42)	AL7 AL8 AL9 APPLY ARCIN CONTRL DL2 IMPULS TH1 TH2 TH3 TH3	T	

SYMBOL	MATH Symbol	CODE	DESCRIPT	ION	BLOC	TOFAGE K	LOC	SUBROU Subr	CODI	USAGE VAR
V	V	I Relat	ive velocity.	(FT/SEC)		<i>,</i> ,,	91)	AL1 AL4 AL7 AL8 BCOND BRORY ENUPT ENUPT ENUPT INTERP INTER	1 1 0 M 0 1 1 1	V V V V V V V V V V V V V V V V V V V
VDA	K(3)	0 Expii	cit partial of $K^{\{3\}}$ wrt λ_{ψ}	øhen ∝ is optimal.	/MATS	/(16)	ALGCON AL1		VDA VDA

SUBRØUTINE AL2

\(\)

Purpose

AL2 evaluates the constant angle of attack constraint, Equation 5.2-1 in Vol. I.

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ALZ
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DYNA
DYNA
            1.
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                                                                                             SUBROUTINE AL2
                                                                         THIS ROUTINE APPLIES WHEN ALPHA IS A CONSTANT

LOGICAL SMITCH, ILOAD
REAL MACH, ISP, ISPV, ISPR, ISPM, ISPT, ISPT, ISPT, ISPT, ISPT, ISPM, ISPR, ISPR,
                                           5000
                                                                                                                                                                                                                 THIS ROUTINE APPLIES WHEN ALPHA IS A CONSTANT
   8.
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XK3MD XKIMA
XK3ZD XKIZA
XK3GV XKIPV
XK3GV XKIGG
XK3RG XKIGG
XK3RG XKIGG
XK3RP XKIG
XK3RP XKIOP
XK3MP XKIZP
XK3MP XKIZP
XK3MP XKIZD
XK3MD XKIZO
XK3MU XKIZU
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74.
                                                                                                                                       XK2ZV
XK2ZRG
XK2ZRP
XK2ZRP
XK2ZRO
XK2ZRO
XK2ZRO
XK2ZRO
XK2ZRO
                                                                                 +XK1RG
+XK1MG
+XK1RP
+XK1MP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  MATS
MATS
MATS
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MATS
                                                                                  +XK10R
+XK1ZR
+XK1M0
                                                                                 *XKIMU XKZMU
*XKIZM XKZZM
*XKPI1Z XKPI22
COMMON /MATS/
                                                                                 *DPDY(3, 8), DEPDEY(2, 8), DPDL(3, 3), PROD5(3, 64), PROD9(2, 24)
COMMON /MATS/
```

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		ST BLOCE	OF AG	E LOC	SUBPOUT SUBR (
ALPHA	α	I Ang	gle of attack	(RAD)	/DYNA	/(AEROCO ALGCON ALZ ARCIN CONTRL ENYPRO MOMECO NPLANE OUTPUT TRAJIN UT	R 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA
CALPHA	C_		lue for angle of attack in case constant a tack constraint is used.	angle of (RADS)	/DYNA	/(161)	AL2 NPLANE		CALPHA Calpha

SUBRØUTINE AL3

Purpose

AL3 evaluates the untrimmed lift constraint, Equation 10.4-1 in Vol. I. In addition, it computes the explicit first and second partials of this constraint with respect to the state and control as they are needed.

_	SUBROUTINE AL3
CCC	THIS ROUTINE APPLIES WHEN THE UNTRIMMED LIFT LIMIT
С	LOGICAL SWITCH, ILOAD
	LOGICAL SWITCH, ILOAD REAL MACH, ISP', ISPR, ISPR, ISPY, ISPYY, ISPYR, ISPYM, *ISPYT, ISPRA, ISPRA, ISPRA, ISPAT, ISPTT, LIFT', *LIFTR, LIFT', LIFT'Y', LIFT'YR, LIFT'YR, LIFT'RR, LIFT'RR, MUR, LIFT'RA, *IRATED, ISPFF ISPFF REAL MACHY, MACHY, MACHYR REAL LIFTM, LIFT'YR, LIFTMR, LIFTMA COMMON /DYNACH, LIFTMR, LIFTMR, LIFTMA
	*LIFTR, LIFTA, LIFTVÝ, LIFTVR, LIFTVA, LIFTRR, LIFTRA, MUR, LIFTAA,
	REAL MACHY, MACHR, MACHYR, MACHRR
	REAL LIFTM, LIFTVÁ, LIFTRÁ, LIFTMA, LIFTMA COMMON /DYNA/
	COMMON /OYNA/ *XX ,TIME ,SINGAM,COSGAM,OMEGA ,OMEGA2,R ,G ,SINA , *COSA ,DYNO11,OMEGAT,TAMP ,PA
	*COSA OVNO11 OMEGAT TAMP PA RO CS TEMPR PAR *ROR CSR TEMPRR PARR RORR CSRR KODE MACH Q *QV OR OVY OVR ORR FVAC FVACV FVACR FVACM *FVACT FVACVY FVACVR FVACRR FVACTT MACHV MACHR ISP
	*FVACT , FVACVY, FVACVR, FVACRR, FVACTT, T , MACHY , MACHR , ISP ,
	*ISPV ,ISPR ,ISPM ,ISPT ,ISPVV ,ISPVR ,ISPVR ,ISPVT ,ISPRR , *ISPRM ,ISPRT ,ISPMM ,ISPMT ,ISPTT ,LIFTV ,LIFTR ,LIFTM ,
	*LIFTYV'LIFTYR'LIFTYA'LIFTRR'LIFTRA'DRAGA 'DRAGA 'DRAGA 'DRAGA '
	*LIFTVM, LIFTMM, LIFTMM, LIFTMA, DBR , DBRR , GAMMAD, AE , TAX ,
	+MUR ,XKG ,XKP ,AKIN ,CDO ,CDOM ,CLO ,FK ,XCGM ,
	+XCGMM,ZCGM,ZCGMM,XJV,XJR,XJVV,XJVR,XJVR,XJRR,MACHVR, +MACHRR.SIN2RO.COS2RO.COS2GM.CM, CMA CMM CMAA CMMM
	+CMAM CMO CMOM CMOMM CMAMM ULFTY ULFTR ULFTYY, ULFTYR
	*CDOMM , CLAMM , CLOMM , CLOMM , DYN149, CT , CODAE , SIDAE , COD ,
	#SID DELINE,CDE ,XCG ,XCG ,XJ ,XRCG ,CALPHA,ALRAX , #DB ,ULFT ,CULFT ,ULFTA ,TSTAGE,TIMES ,XRCGAA,IRATED,FRATED
	*COSA OVNO11 OMEGAT TAMP PA RO CS TEMPR PAR PAR ROR CSR TEMPR PAR ROR CSR TEMPR PARR ROR CSR KODE MACH OF VOY OR OVY DY OR ORR FYACT FYACY
	CORRON /DYNA/ *MTT , J1 , J2 , J3 , XMCGA , FVACF , ULFTAA, ISPF , ISPFF , *LOAD , FKM
	*DYN199, DYN200, XMCGV , XMCGR , XMCGV , XMCGVR, XMCGVR, XMCGVA,
	*XMCGRR,XMCGRM,XMCGRA,XMCGMM,XMCGMA,RORRR ,DYN214,DYN215,DYN216, *DYN217,IDAM ,TAIRB ,TAIRBY,TAIRBH,TARBYY,TARBHH,TARBYH,SFC
	*MTT JZ J3 XMCGA FVACF ULFTAA, 1SPF ISPFF 1LOAD FKM FKMM SWITCH, 1NDF CL CLA CLM CLM CLMA CD CDA CDAM CDAM DYN198, CD CDA CDM CDAM DYN198, CD CDA CDM CDAM DYN198, CD CDAM CDAM CDAM CDAM COMM XMCGWA
	COMMON /MATS/
	P1 P2 P3 XK1 XK2 XK3 XK1T XK2T XK3T , WAST , XK1D XK1D XK3D XK1A XK2A XK3A VBA GDA PDA , XK1D XK2D XK3D XK3A XK3A XK3A YBA GDA PDA , XK3A XK3A XK3A XK3A YBA , XK3A XK3A XK3A XK3A XK3A XK3A XK3A XK3A
	י אולאלי לוואלי אולאלי
	, כַּרָחֹג, רַרַחֹג, בַּרַחֹג, וַרַחַג, אוּמַא, אוּמַא, אוואג, אוואג, אוואג,
	*XKIV XK2V XK3V XK1G XK2G XK3G XK1P XK2P XK3P *XK1R XK2R XK3R XK10 XK20 XK30 XK1U XK2U XK3U *XK1R XK2R XK3R XK17 XK27 XK37 XK1V XK2V XK3U
	HYKING THOUGH THOUGH THOUGH THOUGH THOUGH THOUT
	*XK16D XK2GD XK3GD XK1GA XK2GA XK3GA XK1FT XK2FT XK3FT
	***XKIPD , XK2PD , XK1PA , XK2PA , XK3PA , XKRT , XK2RT , XK3RT , ***XK1RD , XK2RO , XK3RO , XK1RA , XK2RA , XK3RA , XK1OT , XK2OT , XK3OT , ***XK1RO , XK2OO , XK3OO , XK1OT , XK2OA , XK3OA , XK1UT , XK2UT , XK3UT , ***XK1UD , XK2UD , XK3UD , XK1UA , XK2UA , XK3UA , XK1UT , XK2MT , XK3MT , XK2MT , XK3MT , XK2MT , XK3MT , XK2MT , XK3MT , XK1UD , XK2MD , XK1MD , XK2MD , XK1MA , XK1ZT , XK2ZT , XK3ZT , XXXZT , XXX
	*XK1UD XK2UD XK3UD XK1UA XK2UA XK3UA XK1MT XK2MT XK3MT
	COMMON /MATS/ **XKIMD XK2MD XK3MD XK1MA XK2MA XK3MA XK1ZT XK2ZT XK3ZT XK3ZT XK1ZT XK2ZT XK3ZT XK1MA XK1ZT XK2ZT XK3ZT XK1MA XK2MA XK3MA XXXMA X

	*XK10V ,XK20V ,XK30V ,XK1UV ,XK2UV ,XK3UV ,XK1MV ,XK2MV ,XK3MV ,
	*XK1ZV XK2ZV XK3ZV XK1GG XK2GG XK3GG XK1PG XK2PG XK3PG *XK1RG XK2RG XK3RG XK1OG XK2OG XK3OG XK1UG XK2UG XK3UG
	**XK1ZV XXZZV XX3ZV XX1GG XXZGG XX3GG XX1PG XX2PG XX3PG XX1PG XX2PP XX3PF XX1PF XX2PP XX3PP XX1PF XX2PF XX3PF XX3P
	**XIRG XX2RG XX3RG XX10G XX20G XX30G XX10G XX20G XX30G XX30G XX10G XX30G XX30G XX10G XX30G XX10G XX30G XX10G XX30G XX10P

	→XK1MO ,XK2MO ,XK3MO ,XK1ZO ,XK2ZO ,XK3ZO ,XK1UU ,XK2UU ,XK3UU , →XK1MU ,XK2MU ,XK3MU ,XK1ZU ,XK2ZU ,XK3ZU ,XK1MM ,XK2MM ,XK3MM ,
	COMMON / MATS / *** ********************************
	COMMON /MAIS/ *DPDV(3, 8) DPDEV(2, 8), DPDL(3, 3), PROD5(3, 64), PROD9(2, 24) COMMON /MAIS/



FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		ST BLOC	ORAG	LOC	SUBROU SUBR		E USAGE
3111800	STHOOL				5101	<u>`</u>		3004		E 444
CULFT	C _{L,}	I	Magnitude of untrimmed lift lmit	(LB5)	/DYNA	/(165)	AL3 NPLANE	1	CULFT
ULFT	L	I	Untrimmed merodynamic lift	(LBS)	/DYNA	/(164)	AL3 NPLAME UT	I I	ULFT ULFT ULFT
ULFTA	9L ₄ /9¤	1	See symbol		/DYNA	/(166)	AL3 UT	I	ULFTA ULFTA
ULFTAA	3 ² L _u /3 a 2	1 :	See symbol		/DYNA	/(178)	AL3 UT	I	ULFTAA
ULFTR	al _u /ar	1 :	See symbol		/DYNA	/(133)	AL3 UT	ì	ULFTR ULFTR
ULFTRA	∂ ² L _u /∂R∂∝	"I :	See symbol		/DYNA	/(138)	AL3 UT	i	ULFTRA Ulftra
ULFTRR	∂ ² L _u /∂R ²	1 :	See symbol		/DYNA	/(137)	AL3 UT	ĭ	ULFTRR ULFTRR
ULFTV	9L " /9A	1 :	See symbol		/DYMA	/(132)	AL3 UT	1	ULFTV ULFTV
ULFTVA	∂ ² L _u /∂V∂∝	1 9	See symbol .		/DYNA	/(136)	AL3 UT	I M	ULFTVA ULFTVA
ULFTVR	a²L _w /avaR∙	1 9	See symbol		/DYNA	/(135)	AL3 UT	I	ULFTVR ULFTVR
ULFTVV	∂ ² L _u /∂V ²	1 9	See symbol		/DYNA	/(134)	AL3 UT	I M	ULFTVV ULFTVV
· ··										



SUBRØUTINE AL4



Purpose

AL4 evaluates the vertical rise and pitchover constraint, Equation 10.1-1 in Vol. I. Moreover, it computes the explicit first and second partials of this constraint with respect to the state and control as they are needed.

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95.
          C
                                                                                                                                          AL4
AL4
                      ASF(X, Y) = (XKG*Y - XKP*X)/SQUARE
BSF(E, F, G, H) = (YZMX2*(E*H + G*F) + TWOXY*(E*G - F*H))/SQSQ
THIS ENTRY COMPUTES 2ND PARTS. W/RESP. TO STATE
                                                                                                                                          AL4
           C
                                                                                                                                          AL4
AL4
AL4
                      ENTRY AL4020
ASSIGN 6 TO IGO
ASSIGN 3 TO LABL
GO TO 2
                                                                                                                                          THIS ENTRY COMPUTES MIXED 2ND PARTS, \mbox{\ensuremath{\mathsf{W/RESP}}} . TO STATE AND CONTROL
           C
                      ENTRY AL4011
ASSIGN 10 TO 160
ASSIGN 5 TO LABL
GO TO 4
  99.
101.
102.
103.
104.
105.
106.
107.
108.
110.
          C
                                              THIS ENTRY COMP. 1ST PARTS. W/RESP. TO STATE
                     ENTRY AL4010
ASSIGN 20 TO 1GO
ASSIGN 5 TO LABL
GO TO 4
         C
                                              THIS ENTRY COMP. 2ND PARTS, W/RESP. TO CONTROL
                      ENTRY AL4002
ASSIGN 30 TO IGD
GO TO 5
                                                                                                                                          THIS ENTRY COMP. 1ST PARTS. W/RESP. TO CONTROL
           C
111.
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118.
119.
                      ENTRY AL4001
ASSIGN 40 TO 160
GD TO 5
                                             THIS ENTRY EVAL. COSTRAINING EQ. ONLY
           C
                      ENTRY AL4000
                     ASSIGN 50 TO 160
60 TO 5
                 INITIALIZATION FOR 2ND PARTS W/RESP TO STATE
           C
120.
121.
122.
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124.
125.
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           E
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AL4
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AL44
AL44
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| XKGPP = -OMEGA*COSRHO*(2.*V*SINPSI + R*OMEGA*SINRHO*COSPSI*SINGAM) ALQ
| XKGPP = -(V*COSGAM)**2/(R*COSRHO)*SINRHO*SINPSI + OMEGA*COSRHO
| * (2.*V*COSPSI*SINGAM - R*OMEGA*SINRHO*SINPSI) ALQ
| XKGPR = -OMEGA*COSRHO*SINRHO*SINPSI*SINGAM ALQ
| XKGPR = SINRHO*COSPSI*(OMEGA*COSRHO - (V/R*COSGAM)**2/COSRHO) ALQ
| XKGPO = -OMEGA*(R*OMEGA*COSZRO*SINPSI*SINGAM + 2.*V*SINRHO*COSPSI) ALQ
| XKGPO = -OMEGA*(R*OMEGA*COSZRO*SINPSI*SINGAM + 2.*V*SINRHO*COSPSI) ALQ
| XKGRO = COSPSI*((V/COSRHO*COSGAM)**2/(R*COSRHO) ALQ
| XKGRR = 2.*XINRHO*SINPSI*SINGAM ALQ
| XKGRO = 2.*SINRHO*SINPSI*(V/R*COSGAM)**2/(R*COSRHO) ALQ
| XKGRO = OMEGA*(COSZRO*COSPSI*SINGAM - SINZRO*COSPSI) ALQ
| XKGOO = -2.*OMEGA*(R*OMEGA*COSZRO - (V/R*COSGAM/COSRHO)**2) ALQ
| XKGOO = -2.*OMEGA*(R*OMEGA*COSZRO*COSSRO*SINPSI) ALQ
| XKGOO = -2.*OMEGA*(R*OMEGA*COSZRO*COSSRO*SINPSI) ALQ
| XKOOO = -2.*OMEGA*(R*OMEGA*(V*COSRHO*COSRHO)**2) ALQ
| XKOOO = -2.*OMEGA*(R*OMEGA*COSZRO*COSSRO*SINPSI) ALQ
| XKOOO = -2.*OMEGA*(R*OMEGA*COSZRO*COSPRO*COSRHO*SINPSI) ALQ
| XKOOO = -2.*OMEGA*(R*OMEGA*(V*COSRHO*COSPSI*SINGAM - R*OMEGA*SINPSI) ALQ
| XKOOO = -2.*OMEGA*(V*COSRHO*COSPSI*SINGAM - R*OMEGA*SINPSI ALQ
| XKOOO = 
                152.
153.
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167.
168.
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175.
176.
177.
178.
                                                                                                                                                                          COMPUTE EXPLICIT 2ND PARTS W/RESP

ANGLE

3 PVV = ASF(XKGVV, XKPVV) + BSF(XKGV, XKPV, XKGV,
PGV = ASF(XKGVV, XKPVV) + BSF(XKGV, XKPV, XKGV,
PPV = ASF(XKGVV, XKPVV) + BSF(XKGV, XKPV, XKGV,
PPV = ASF(XKGVV, XKPVV) + BSF(XKGV, XKPV, XKGV,
PPV = ASF(XKGVV, XKPVV) + BSF(XKGV, XKPV, XKGV,
PGV = ASF(XKGGV, XKPVV) + BSF(XKGV, XKPV, XKGV,
PGG = ASF(XKGGV, XKPVV) + BSF(XKGV, XKPV, XKGV,
PGG = ASF(XKGGV, XKPGV) + BSF(XKGV, XKPV, XKGV,
PPQ = ASF(XKGGV, XKPGV) + BSF(XKGV, XKPV, XKGV,
PPQ = ASF(XKGGV, XKPPV) + BSF(XKGV, XKPV, XKGV,
PPP = ASF(XKGPV, XKPPV) + BSF(XKGV, XKPV, XKGV,
PPV = ASF(XKGPV, XKPPV) + BSF(XKGV, XKPV, XKGV,
PPV = ASF(XKGVV, XKPVV) + BSF(XKGV, XKVV, XKGV,
PPV = ASF(XKGVV, XKVPV) + BSF(XKGV, XKVV, XKGV,
PPV = ASF(XKGVV, XKVVV) + BSF(XKGV, XKVV, XKGV,
PPV = COSPHI*PV*PV - SINPHI*PV*
CPVV = COSPHI*PV*
                                                                                                                                                                                                                          60 TO 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            COMPUTE EXPLICIT 2ND PARTS W/RESP. TO STATE OF BANK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  XKPG)
XKPG)
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         183.
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         199.
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         198.
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201.
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      204.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     INITIALIZATION FOR 1ST PARTS W/RESP TO STATE AND/OR MIXED 2ND PARTS.
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      224.
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226.
227.
228. C
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       232.
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234. C
     236.
236.
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238.
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241.
                                                                                                             INITIALIZATI

5 TCDAE = T+CODAE
TSDAE = T+SDAE
DBCA = DB+COSA
DBSA = DB+SIMA
YY = TSDAE + LIFT - DBSA
ZZ = TCDAE + LIFTA - DBCA
GO TO 160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            242.
     242.
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301. C
302. 40 XK3T = COSPMI+SIDAE
303. XK3D = -TCDAE+COSPMI
304. XK3A = ZZ+COSPMI
305. 50 XK3 = YY+COSPMI + M+XKG
306. C
307. C
307. C
308. RETURN
309. END
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FORTRAN Symbol	MATH Symbol	CODE .	DESCRIPTION	STORAGE BLOCK LOC	SUBROUTINE USAGE
		· · · · · · · · · · · · · · · · · · ·			
CODAE	cos(a - s _E)	i See symbol		/DYNA /(15	1) AL1 I CODAE AL4 I CODAE AL6 I CODAE AL7 I CODAE AL8 I CODAE AL9 I CODAE ALP I CODAE CONTRL I CODAE NLDRY I CODAE TH3 I CODAE UT O CODAE
COSA	C 0 5 C	I See symbol		/DVNA /(3:	0) AL1 COSA AL4 COSA AL6 COSA AL7 COSA AL8 COSA AL9 COSA APPLY COSA CONTRL COSA OUTPUT COSA OUTPUT COSA TH3 COSA
COSGAM	C 0 5 7	I See symbol	•••	/DYNA /{	AL1 I COSGAM AL4 I COSGAM AL7 I COSGAM AL8 I COSGAM AL9 I COSGAM AL9 I COSGAM MLDRY I COSGAM OUTPUT I COSGAM POBCGL I COSGAM STATEF M COSGAM
COSPHI	cos∲	I See symbol		/DYNA /(9:	ALA I COSPHI ALA I COSPHI APPLY I COSPHI ARCIN O COSPHI CONTRL M COSPHI DUTPUT I COSPHI
COSPSI	c o s♥	I See symbol		/DYNA /(99	AL4 I COSPSI AL7 I COSPSI AL8 I COSPSI AL9 I COSPSI CONTRL I COSPSI MLDRY I COSPSI PDBCOI I COSPSI STATEF O COSPSI
COSRH O	COSP	1 See symbol		/DYNA /(9:	AL4 I COSRHO AL7 I COSRHO AL8 I COSRHO AL9 I COSRHO CONTRE I COSRHO NLDRY I COSRHO OUTPUT I COSRHO PDBCQL I COSRHO STATEF M COSRHO
COS26M	cos27	I See symbol		/DYNA /(121) AL4 I COS2GM STATEF O COS2GM
C052 80	co \$ 2 p	1 See symbol		/DYNA /(120	AL4 I COS2RO AL7 I COS2RO AL8 I COS2RO ALDRY I COS2RO STATEF O COS2RO

FORTRAN Symbol	MATH Symbol	COD	E DESCRIPTION		BLOC	ORA(LOC	SUBROL SUBR	COD	E USAGE
DS	D	1	Base drag	(LBS)	/DYNA	'n	163)	AL1 AL4 AL6 AL7 AL8 AL9 CONTRL NLDRY OUTPUT STATEF TH3 UT	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	08 08 08 08 08 08 08 08
DBR .	∂D _b /∂R	. 1	See symbol .		/DYNA	/(86)	AL1 AL4 AL6 AL7 AL8 AL9 APPLY STATEF TH3 UT	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	DBR DBR DBR DBR DBR DBR DBR DBR
OBRÁ	a²D _b ∕aR²	1	See symbol		/BYNA			AL4 AL6 AL7 AL8 AL9 APPLY STATEF TH3 UT	I I I I I I	DBRR DBRR DBRR DBRR DBRR DBRR DBRR DBRR
6	9	1	Instantaneous gravitational acceleration	(FT/SEC ²)	/DYNA	/(8)	AL4 AL7 AL8 AL9 CONTRL NLDRY STATEF	1	666666
GAMMAD		1	Pitch rate .	(RAD/SEC)	/DYNA	/(88)	AL4 ARCIN CONTRL NLDRY	1 0 1	SAMMAD SAMMAD SAMMAD SAMMAD
*	h .	ı	Integration step size in quasitime.		/0		2)	AL4 INARC MADAMS RKUTT1 RKUTT2 SALVE WRAPUP	I I	H H H H H H DT
LIFT	L	ŧ	Aerodynamic lift	(LBS)	/DYNA	/(60)	AL4 AL5 AL6 APPLY CONTRL ENYPRO OUTPUT TH3 UT	I I I I	LIFT LIFT LIFT LIFT LIFT LIFT LIFT LIFT
LIFTA	∂L/∂ e	ı	See symbol		/BYNA	/(63)	AL1 AL4 AL5 AL6 APPLY TH3 UT	I I I I	LIFTA LIFTA LIFTA LIFTA LIFTA LIFTA

ALS I LI TYPY 32L/3V3R I See symbol /DVMA /(65) ALS I LI APPLY I LI THS I LI APPLY I LI					•	•						
Company Comp							·					
ALS LI APPRIL AP		FORTRAM Symbol	MATH Symbol	COD	E	DESCRIPTION	···········	BLOC	ORA(SUBPOUT SUBP C	ODE VAR
LIFTUR 28L/2V2R 1 See symbol		LIFTVM	∂ ² L/∂V∂∎	1	See symbol			/DYNA	70	82)	ALS AL6 APPLY TH3	I LIFTVI I LIFTVI I LIFTVI
LIFTVV 22L/2V2 I See symbel //OVHA /(64) ALS I LL ALS I		LIFTVR	a ² l/avar	1	See symbol			/DYNA	/(65)	AL4 AL5 AL6 APPLY TH3	I LIFTVI I LIFTVI I LIFTVI I LIFTVI I LIFTVI
N		LIFTVV		I	See symbol			/DYNA	".	64)	AL4 AL5 AL6 APPLY TH3	I LIFTY I- LIFTY I LIFTY I LIFTY I LIFTY
DREGA		M ·	•	1	Mass .		(6'5)	/0	/(97)	AL4 AL7 AL8 AL9 APPLY BRANPT COSTAB INTRPT NLDRY OUTPUT SALVE STATEF	I
ALT I OM ALS I OM TRAJIM O DR ALS I OF APPLY I PG A		OMEGA	•	I	Earth rotation	rete	(RAD/SEC)	/DYMA	/(5)	AL4 AL7 CONTRL PDBCOL	I OMEGA I OMEGA I OMEGA I OMEGA
PG		OREGA2	• ²	ı	See symbol			/DYMA	11	6)	AL7 AL8 AL9 NLDRV	DMEGAZ OMEGAZ OMEGAZ OMEGAZ
PGV		PG	•,	A	See symbol			/MATS	/(551)	AL4 APPLY ARCIN	M PG I PG D PG
PGV	r	P66	*	Ħ	See symbol	•	•	/MATS	/(560)	AL4	N P66
POG		PGV		n	See symbol	•		/MATS	/(556)	AL4	N PGV
PDD		PO	•	Ħ	See symbol			/MATS	/(554)	AL4	M PO
POD # N See symbol		P06	•	•	See symbol	•		/MATS	/(563)	AL4	M P06
POP # N See symbol		POO	ø '	M	See symbol	•		/MATS	/(569)	AL4	M P00
POR		POP	•	Ħ	See symbol			/MATS	/(566)	AL9 (n POP
POV # M See symbol		POR	•	A	See symbol			/MATS	/(568)	AL4 I	M POR
PP # See symbol /MATS /(552) AL4		POV	•	M	See symbol			/MATS	/(559)	AL4	M PDV
PPP # M See symbol /MATS /(564) AL4 M PPI PPV # M See symbol /MATS /(557) AL4 M PPI		PP		n	See symbol '		•	/MATS	/(552)	AL4	A PP
PPP P M See symbol /MATS /(564) AL4 M PPI PPV M M See symbol /MATS /(557) AL4 M PPI		PPG	***	Ħ	See symbol			/MATS	/(561)	AL4	4 PPG
		PPP		. #	See symbol	•		/MATS	/(564)	AL4 I	9 PPP
			∳ 6.01-44	*	See symbol			/MATS	/(557)	AL4 I	9 PPV
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FORTRAM Symbol	MATH Symbol	DESCRIPT	ION -B	STORAL	GE LOC	SUBROUTIN	E USAGE
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PR	≠ _h	M See symbol	/RA	TS /(553)	AL4 M	PR
PRG	ø _{hz}	A See symbol	/84	TS /(562)	AL4 M	PRG
PRP	**	M See symbol	/flA	TS /(565)	AL4 M	PRP
PRR	Abb	M See symbol	/MA	T5 /(567)	AL4 #	PRR
PRV	ø _{hv}	A See symbol	/fla	TS /(558)	AL4 M	PRV
PV	• , .	A See symbol	/ MA	TS /(550)	AL4 M	PV
PVV	٠.,	A See symbol	/#A	TS /(555)	AL4 M	PVV
Ř	R] Radial distance from earth cen	ter to vehicle /DY (FT)	NA ≯U·	7-)	AL4 I AL7 I AL8 I CONTRL I ENVPRO I NLDRV I PDBCQL I QLTOSZ I STATEF M	R R R R R R R R R R R R R R R
SIDAE	sin(a-6 _E)	l See symbol .		HA /(152)	AL1 I AL4 I AL6 I AL7 I AL8 I AL9 I APPLY I CONTRL I TM3 I UT 0	SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE
	s i na	í See symbol	/D4	1A /(ALI I AL4 I AL6 I AL7 I AL8 I AL9 I APPLY I COMTRL I OUTPUT I TM3 I UT M	SINA SINA SINA SINA SINA SINA SINA SINA
SINGAM	sin7	I See symbol	/BY!	¥A /(,	ALI I ALY I ALY I ALB I ALB I CONTRL I MLDRY I PDBCQL I STATEF M	SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM
SINPHI	sin≠	I See symbol .	/BY!	IA /(AL4 1 APPLY I CONTRL M	SINPHI SINPHI SINPHI SINPHI SINPHI
SINPSI	sin∳	See symbol	/DYI	IA /(94)	AL4 I AL7 I AL8 I AL9 I CONTRL I NLDRY I PDBCQL I	SINPSI SIMPSI SIMPSI SIMPSI SIMPSI SIMPSI SIMPSI SIMPSI SIMPSI

	FORTRAN Symbol	MATH Symbol	COD	E	DESC	RIPTIC	N		ST BLOC	ORAG K	E LOC	SUBROU SUBR	T I N	E USAGE
	SINRHO	s i n p	1	See symbol					/DYNA	/(96)	AL4 AL7 AL8 AL9 CONTRL NLDRY OUTPUT PDBCOL STATEF	; ; ;	SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO
	SIN2RO	sin2p	i	See symbol					/ DYNA	/(119)	AL4 AL7 AL8 NLDRV STATEF	I	SIN2RO SIN2RO SIN2RO SIN2RO SIN2RO
•	í	Ť	-	Thrust				(LBS)	/DYNA	/(42)	ALGCON AL1 AL4 AL6 AL7 ALB AL9 APPLY ARCIN CONTRL DL2 IMPULS TMPULS TMP TM2 TM3 TM3	# I I I I I I I I I I I I I I I I I I I	T
1	•	v	1	Relative veloc	:ity.			(FT/SEC)	/D	/(91)	AL4 AL7 AL8 BCOND BNDRY TCONTAL ENOPTO ENUPRO FETCH INTERP	0 I I I	V V V V V V V V V V V V V V V V V V V
;		1	ι	The questime	variable.					K	1)	AL4 BNDRY ERROR FETCH FORCES INARC INTERP MADAMS RKUTT2 SALVE	10101MIMMMI	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1	K.E.	k,	1	Algebraic equa	tion used	in vertical	rise	and	/DYNA	/(101)		1	XKG
1	KKP	k,	1	Algebraic equa	tion used	in vertical	rise	***	/DYNA	/(102)		I	XKP XKP

SUBRØUTINE. AL5

Purpose

AL5 evaluates the unpowered total acceleration limit constraint, Equation 10.5-1 in Vol. I. In addition, it computes the explicit first and second partials of this constraint with respect to the state and control as they are needed.

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9.
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                                                                                                                                                                                                                                                                                                          THIS ROUTINE APPLIES WHEN AN UNPOWERED TOTAL ACCEL. LIMIT IS IN EFFECT.
                                                                                                                         GLOBAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ARCDAT
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21.
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**DREF MCND ARCDA(40)

**EQUIVALENCE(SREF ARCDA)

**LOGICAL SWITCH, ILOAD

**REAL MACH, ISP, ISPN, ISPN, ISPN, ISPV, ISPV, ISPV, ISPV, ISPN, ISPN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ARCDAT
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TYNNA A A 219
TYNNA A A 219
THE TOTAL THE TARACTES SEE THE TARAC
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MATS
MATS
MATS
MATS
MATS
MATS
                                                                                        THIS ENTRY COMP. EXPLICIT 2ND PARTS. W/RESP ID SINIE

ENTRY ALSO20

XK3VY = LIFT=LIFTVY + LIFTY==2 + DRAG=DRAGVY + DRAGY==2

XK3VY = XK3VY + XX3VY

XK3RY = LIFT=LIFTYR + LIFTY=LIFTR + DRAG=DRAGVR + DRAGY=DRAGR

XK3RY = XK3RY + XK3RY

XK3RY = XK3RY + XK3RY

XK3RY = LIFT=LIFTRR + LIFTR==2 + DRAG=DRAGRR + DRAGR==2

XK3RR = XK3RR + XK3RR

XK3RR = LIFT=LIFTRR + LIFTR=LIFTR

XK3RR = XK3RR + XK3RR

XK3RR = XK3RR + XK
                                                                                                                                                                                                  THIS ENTRY COMP. EXPLICIT 2ND PARTS. W/RESP TO STATE
     100
     103.
     106.
    108.
109.
110.
 111.
112.
113.
114.
115.
116.
117.
                                                                                           AND CONTROL

ENTRY ALSO11

XK3VA = LIFT*LIFTVA + LIFTV*LIFTA + DRAG*DRAGVA + DRAGV*DRAGA

XK3VA = XK3VA + XK3VA

XK3RA = LIFT*LIFTRA + LIFTR*LIFTA + DRAG*DRAGRA + DRAGR*DRAGA

XK3RA = XK3RA + XK3RA

XK3VA = XK3RA + XK3RA

THIS ENTRY COMP EXPLICIT 1ST PARTS W/RESP TO STATE

ENTRY ALSO10

XK3V = LIFT*LIFTV + DRAG*DRAGV
120.
121.
122.
123.
124.
125.
126.
127.
128.
129.
                                        C
                                                                                         ENTRY ALSO 10

XK3V = LIFT-LIFTV + DRAG-DRAGV

XK3V = XK3V + XK3V

XK3R = LIFT-LIFTR + DRAG-DRAGR

XK3R = XK3R + XK3R

XK3M = LIFT+LIFTM - GR-GMAX++2+M

XK3M = XK3M + XK3M

THIC ENTRY
                                                                                                                                                                                                  XK3M
THIS ENTRY COMP EXPLICIT 2ND PARTS W/RESP TO CONTROL
                                                                 THIS ENTRY COMP EXPLICIT 2ND PARTS W/RESP TO CONTROL

STATEMENT ALSO THIS ENTRY COMP EXPLICIT 2ND PARTS W/RESP TO CONTROL

KASAA = LIFT+LIFTAA + LIFTA**2 + DRAG**DRAGAA + DRAGA**2

KASAA = KASAA + KASAA

THIS ENTRY COMP EXPLICIT 1ST PARTS W/RESP TO CONTROL

KASA = LIFT+LIFTA + DRAG**DRAGA

KASA = KASA + KASA

THIS ENTRY EVAL CONSTRAINING EQ. ONLY.

EMTRY ALSO OO

TERMS = GRAX**W

KAS = LIFT**2 + DRAG**2 - TERMS**2
                                    C
131.
132.
133.
134.
135.
136.
137.
138.
140.
141.
                                                                                           RETURN
```



FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION		STOR BLÖCK	AGE LOC	SUBROUTINE USAGI SUBR CODE VAR
DRAG	D	I Aerodynamic drag	(LBS)	/DYNA /	'(69)	AL5 I DRAG AL7 I DRAG AL8 I DRAG AL9 I DRAG APPLY I DRAG CONTRL I DRAG ENVPRO I DRAG OUTPUT I DRAG
ORAGA -	∂D/∂α	f See symbol		/DYNA /	(72)	ALI I DRAGA AL5 I DRAGA AL7 I DRAGA AL8 I DRAGA AL9 I DRAGA APPLY I DRAGA APPLY I DRAGA TM3 I DRAGA UT M DRAGA
DRAGAA	∂ ² D/∂α ²	1 See symbol		/DYNA /	(78)	AL1 I DRAGAM AL5 I DRAGAM AL7 I DRAGAM AL8 I DRAGAM AL9 I DRAGAM APPLY I DRAGAM TH3 I DRAGAM UT M DRAGAM
DRAGR	`a0/aR	1 See symbol	•	/84MÅ /	(⁻ 71)	AL5 I DFAGR AL7 I DRAGR AL8 I DRAGR AL9 I DRAGR APPLY I DRAGR TH3 I DRAGR UT M DRAGR
DRAGRA	a ² D/aRaα	I See symbol		/DYNA /	(77)	AL1 I DRAGRI AL5 I DRAGRI AL7 I DRAGRI AL8 I DRAGRI AL9 I DRAGRI APPLY I DRAGRI THAS II DRAGRI UT M DRAGRI
DRAGRR	a ² D/aR ²	I See symbol		/DYNA /	(76)	ALS I DRAGRE AL7 I DRAGRE AL8 I DRAGRE AL9 I DRAGRE APPLY I DRAGRE TM3 I DRAGRE UT M DRAGRE
DRAGV	a D/a V	I See symbol .		/DYNA /	(70)	AL5 I DRAGY AL7 I DRAGY AL8 I DRAGY AL9 I DRAGY APPLY I DRAGY TH3 I DRAGY UT M DRAGY
DRAGVA	∂ ² D/∂V∂œ	I See symbol		/DYNA /	(75)	AL1 I DRAGVA AL5 I DRAGVA AL7 I DRAGVA AL8 I DRAGVA AL9 I DRAGVA APPLY I DRAGVA TH3 I DRAGVA UT M DRAGVA



FORTRAN SYMBOL	MATH SYMBOL	CODE	DESCRIPTION	8 L D I	TORA CK	GE LOC	SUBROU SUBR	CODE	USAG! VAR
DRAGVR	a ² D/avar	ī	See symbol	/DYNA	. 10	74)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I I I I	DRAGAF DRAGAF DRAGAF DRAGAF DRAGAF DRAGAF
DRAGVV	9 2 0/94 ₅	J	See symbol	/DYNA		73)	AL5 AL7 AL8 AL9 APPLY TH3 UT]]] 1 1 1 1	DRAGY
GMAX	GWEX	1	Maximum total acceleration g load	/ARCD	AT/(12)	AL5 NPLANE THROTL TH3	i	GMAX GMAX GMAX GMAX
58	9 _F	1	Gravitational acceleration at surface of the earth. (FT/SEC ²)	/ GL08	AL/(1)	AL5 APPLY BRANPT COSTAB COSTAI	I I I I I I I I I I	GR GR GR GR GR GR GR GR GR
LIFT	L	ī	Aerodymamic lift (LBS)	/DYNA		60)	AL5 AL6 APPLY CONTRL ENVPRO	1 1 1 1 1 1	LIFT LIFT LIFT LIFT LIFT LIFT LIFT LIFT
LIFTA	∂L/∂¤	1	See symbol .	/DYNA	· 10	63)	AL1 AL4 AL5 AL6 APPLY TH3 UT	I I I I	LIFTA LIFTA LIFTA LIFTA LIFTA LIFTA
LIFTAA	∂ ² L/∂œ ²	1 !	See symbol	/DYNA	/ (·		AL1 AL4 AL5 AL6 APPLY TH3 UT	t I I I	LIFTAA LIFTAA LIFTAA LIFTAA LIFTAA LIFTAA
LIFTM	∂L/∂•	I :	See sy abol	/DYNA	/(ALS ALG APPLY] ;] ;] ;	LIFTM LIFTM LIFTM LIFTM LIFTM LIFTM
LIFTMA	∂ ² L/∂ s ∂α	1 :	oce symbol	/DYNA	/(AL4 AL5 AL6 APPLY TH3	1 1	LIFTMA LIFTMA LIFTMA LIFTMA LIFTMA LIFTMA



ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORAGE BLOCK LOC	SUBROUTINE USAGE SUBR CODE VAR
LIFTMM	∂ ² L/∂ m ²	l See sýmbol		/DYNA /(84)	AL4 I LIFTMA AL5 I LIFTMA AL6 I LIFTMA APPLY I LIFTMA TH3 I LIFTMA UT O LIFTMA
LIFTR	al/ar	1 See symbol		/DYMA /(62)	AL4 I LIFTR AL5 I LIFTR AL6 I LIFTR APPLY I LIFTR UT G LIFTR
LIFTRA	a ² L/aRa∝	I See symbol	···	/BYNA /(68)	AL1 I LIFTRA AL4 I LIFTRA AL5 I LIFTRA AL6 I LIFTRA APPLY I LIFTRA UT O LIFTRA
LIFTRM	∂ ² L/∂R∂ ∍	1 See symbol		/DYNA /(83)	AL4 I LIFTRM AL5 I LIFTRM AL6 I LIFTRM APPLY I LIFTRM TH3 I LIFTRM UT O LIFTRM
LIFTRR	a²L/aR²	1 See symbol -	. •	/DYNA /(67)	AL4 I LIFTRE AL5 I LIFTRE AL6 I LIFTRE APPLY I LIFTRE TH3 I LIFTRE UT O LIFTRE
LIFTV	9L/9 V	I See symbol		/DYNA /(61)	AL4 I LIFTV AL5 I LIFTV AL6 I LIFTV APPLV I LIFTV UT 0 LIFTV
.1FTVA	∂ ² L/∂V∂α	I See symbol		/DYNA /(66)	AL1 LIFTVA AL4 LIFTVA AL5 LIFTVA AL6 LIFTVA APPLY LIFTVA UT O LIFTVA
.IFTVM	a ² L/a¥a∎	l See symbol	·		
.IFTVR	a ² ∟/a∨aR	I See symbol			
.IFTVV	9 <mark>2</mark> L/3V ²	I See symbol			AL4 I LIFTVV AL5 I LIFTVV AL6 I LIFTVV APPLV I LIFTVV TH3 I LIFTVV UT 0 LIFTVV



FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		BLOC	ORA K	FOC F	SUBRO	COD	USAG
•	W] Weight	(LE	35)	/DYNA	/ <u>(</u>	91)	ALS ENVPRO OUTPU' PDBCO! OLTOS! STATE! TH3	I I I	2 2 2 2

SUBRØUTINE AL6



Purpose

AL6 evaluates the gravity turn constraint, Equation 10.3-1 in Vol. I. In addition, it computes the explicit first and second partials of this constraint with respect to the state and control as they are needed.

```
76.
77.
78.
79.
                     COMMON /MATS/

*PV PG PP PR

*POV PGG PPG PRG

*PON POO PL6 PLP

EQUIVALENCE(PRODI, PROD5)
                                                                                                                                                  MATS
MATS
MATS
MATS
8123...
8123...
8567.8.99
99123...
9967.8.99
9967.8.99
10012...
1006...
                                                THIS ENTRY COMP EXPLICIT 2ND PARTS W/RESP TO STATE
                       ENTRY AL6020
ASSIGN 6 TO IGO
GO TO 5
                                                THIS ENTRY COMP EXPLICIT MIXED PARTS W/RESP TO STATE ALG
                      ENTRY ALGOII
ASSIGN TO TO IGO
GO TO 5
           C
                                                THIS ENTRY COMP EXPLICIT 1ST PARTS W/RESP TO STATE
                      ENTRY AL6010
ASSIGN 20 TO 160
60 TO 5
                                             C
                      ENTRY AL6002
ASSIGN 30 TO 160
60 TO 5
          C
                      ENTRY ALGODI
ASSIGN 40 TO 160
GO TO 5
                      ENTRY ALGODO ASSIGN 50 TO 1GD INITIALIZATION FOR ALL ENTRIES
                     TCDAE = T+CODAE
TSDAE = T+SIDAE
DBCA = DB+COSA
DBSA = DB+SIMA
GO TO IGO
107.
108.
109.
110.
111.
112.
113.
114.
115.
116.
                                                                                                                                                 C
                  2ND PARTS W/I

KK3NV = LIFTVR

KK3NV = LIFTVR

KK3NN = LIFTVR

KK3NR = LIFTRR - DBRR*SINA

KK3NR = LIFTRR

KK3NR = LIFTRR
                                               2ND PARTS W/RESP TO STATE
                10 XK3VA = LIFTVA
XK3RA = LIFTVA - DBR-COSA
XK3RA = LIFTRA - IST PARTS W/
                                               MIXED PARTS W/RESP TO STATE AND CONTROL
120.
121.
122.
123.
                20 XK3V = LIFTW
XK3R = LIFTW
XK3R = LIFTW
XK3R = LIFTW
               128.
129.
130.
131.
               ST PARTS W/RESP

40 XK3T = SIDAE

XK3D = -TCDAE

XK3A = TCDAE - DBCA + LIFTA

CONSTRAINING EQ.

50 XK3 = TSDAE + LIFT - DBSA
134.
135.
136.
137.
138.
139.
140.
                     RETURN
END .
```

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOCK	E LOC	SUBROUTINE U	VA
							-
CODAE	cos(α-δ _E)	I See symbol		/DYNA /(¸	151)	AL7 1 CD AL8 1 CO AL9 1 CO APPLY I CO CONTRL I CO NLDRY I CO TH3 I CO	DAI DAI DAI DAI DAI DAI DAI
COSA	C 0 8 62	I See symbol		/DYNA /(10)	AL1 I CO AL4 I CO AL6 I CO AL8 I CO AL8 I CO AL9 I CO CONTRL I CO CONTRL I CO CUTPUT I CO	5AAAAAAAAAAAAA
OB	· D _b	I Base drag	(LBS)	/DYNA /(163)		
OBR	∂D _b /∂R	I See symbol		/DYNA /(86)		R R R R R R R R
OBRR	∂ ² D _b /∂R ²	I See symbol		/DYNA /(87)		RR RR RR RR RR
LIFT	L	I Aerodynamic (i	. · . · . · . · . · . · . · . · . · . ·	/DYNA /C		AL4 I LIF AL5 I LIF AL6 I LIF APPLY I LIF CONTRL I LIF ENVPRO I LIF OUTPUT I LIF TH3 I LIF UT O LIF	FT FT FT FT

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STOR6 BLOCK	LOC LOC	SUBROUTINE USAGE SUBR CODE VAR
LIFTA	∂L/∂ α	I See symbol		/DYNA /(63)	AL1 I LIFTA AL4 I LIFTA AL5 I LIFTA AL6 I LIFTA APPLY I LIFTA TH3 I LIFTA UT O LIFTA
LIFTAA	∂ ² L/∂α ²	I See symbol		/DYNA /(
LIFTM	∂L/∂ m	I See symbol		/DYMA /(AL4 I LIFTM AL5 I LIFTM AL6 J LIFTM APPLY I LIFTM TH3 I LIFTM UT O LIFTM
LIFTMA	∂ ² L/∂ m ∂α	I See symbol		/DYNA /(85)	AL1 I LIFTMA AL4 I LIFTMA AL5 I LIFTMA AL6 I LIFTMA APPLY I LIFTMA TH3 I LIFTMA UT O LIFTMA
LIFTMA	a ² L/a∎ ²	I See symbol		/DŸNÁ /(84)	AL4 I LIFTMM AL5 I LIFTMM AL6 I LIFTMM APPLY I LIFTMM TH3 I LIFTMM UT O LIFTMM
LIFTR	∂L/∂R	i See symbol		/DYNA /(62)	AL4 I LIFTR AL5 I LIFTR AL6 I LIFTR APPLY I LIFTR TH3 I LIFTR UT O LIFTR
LIFTRA	∂ ² L/∂R∂œ	1 See symbol		/DYNA /(68)	AL1 I LIFTRA AL4 I LIFTRA AL5 I LIFTRA AL6 I LIFTRA APPLY I LIFTRA TH3 I LIFTRA UT O LIFTRA
LIFTRM	∂ ² L/∂R∂m	I See symbol .		/DYNA /(83)	
LIFTRR	a²∟/aR²	i See symbol		/DYNA /(67)	
LIFTV	aL/av	I See symbol	· - ·	/DYNA /(AL4 I LIFTV AL5 I LIFTV AL6 I LIFTV APPLY I LIFTV TM3 I LIFTV UT O LIFTV

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(V

DRTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOC	DRAGE K LO	C	SUBROU SUBR	TINE	USA
						<u>-</u>			
LIFTVA	∂ ² L/∂V∂α	I See symbol		/DYNA	/(66)	AL1 AL4 AL5 AL6 APPLY TH3 UT	I I I I I	LIFT LIFT LIFT LIFT LIFT LIFT
LIFTVM	∂ ² L/∂V∂∎	I See symbol		/DYNA	/(82)	AL4 AL5 AL6 APPLY TH3 UT	1 1 1 1 1	LIFT LIFT LIFT LIFT LIFT LIFT
LIFTVA	a ² l/avar	I See symbol	·	/DYNA	/((55)	AL4 AL5 AL6 APPLY TH3 UT	I i I	LIFT LIFT LIFT LIFT LIFT
LIFTVV	∂ ² L/∂V ²	I See symbol		/DYNA	/((54)	AL4 AL5 AL6 APPLY TH3 UT	1 1 1 1	LIFT LIFT LIFT LIFT LIFT
SIDAE	sln(α-6 _E)	1 See symbol		/DYNA	W 7		AL1 AL6 AL7 AL8 AL9 APPLY CONTRL TH3 UT	I I I I I I I	\$100 \$100 \$100 \$100 \$100 \$100 \$100 \$100
INA	sina.	i See symbol		/DYNA	/(9)	AL1 AL4 AL6 AL7 AL8 AL9 APPLY CONTRL OUTPLT TH3 UT	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	SINI SINI SINI SINI SINI SINI SINI SINI
	τ .	I Thrust	(LBS)	/DYNA	<i>7</i> (*		AL1 AL4 AL6 AL7 AL8 AL9 APPLY ARCIN CONTRL OL2 IMPULS]]] [] [] []	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

SUBRØUTINE AL7



Purpose

AL7 evaluates the dynamic pressure rate constraint, Equation 10.6-1 in Vol. I. In addition, it computes the explicit partials of this constraint with respect to the state and control as they are needed.

```
SUBROUTINE ALT
REAL MAGBY, MU, M, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM

LHT
COMMON /D/
**X M, XI(4), MAGBY, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI,
**ALT, MHO MU, M, TAU, MT, LV LGAM LPSI, LR, LRHO, LMU, LM, LTAU,
**UHT, D169, D110, D410, 25AVE(20), D1(20), NPOINT(20), DELT(20)
DIMENSION MOMES
**DISPRISON MOMES
**LOGICAL SWITCH, LOAD
REAL MACH, ISP ISPY, ISPR, ISPM, ISPT, ISPY, ISPVM, ISPVM, ISPM, 
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         AL7
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D
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DYNA
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DYNA
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DYNA
      26.
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DYMA
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    28.
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31.
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XK2TD
XK43C
XK3C
XK3C
XK3C
XK3CA
XK3CA
XK3CA
XK3CA
XK3CA
                                                                                                                                                                                                                                                                                                                                               , XK2U
, XK2VA
, XK2VA
, XK2PA
, XK2PA
, XK2OA
, XK2UA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               , XK10
, XK19T
, XK19T
, XK10T
, XK10T
, XK1UT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              , XK2VT
, XK2ST
, XK2PT
, XK2PT
, XK2OT
, XK2UT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 , XK3VT
, XK36T
, XK3PT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 , XK IMT
                                                                                                                                                                                                                COMMON /MATS/
+XK1MD ,XK2MD
+XK1ZD ,XK2ZD
+XK1GV ,XK2GV
+XK1GV ,XK2GV
+XK1ZV ,XK2ZV
+XK1RG ,XK2RG
+XK1MG ,XK2RG
+XK1MG ,XK2RG
+XK1MG ,XK2RG
                                                                                            +XK1ZV
+XK1RG
+XK1RG
+XK1RP
                                                                                                                                                    , XK2RP
, XK2MP
, XK2DR
, XK2ZR
, XK2MO
, XK2MU
                                                                                            *XK1MP
*XK1OR
*XK1ZR
                                                                                             *XKIAD
                                                                                            +XK1ZM ,XK2ZM
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76.

777.

78.

78.

801.

823.

844.

85.

869.

991.

992.

994.

995.

996.

997.

100.

101.

103.

104.

106.

1108.

1108.

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1108.

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1108.

1109.

1111.

1112.

1113.
                                                   COMMON /MATS/
PV PR PPR PR
POV PG PPG PRG
POR POO PLG PLP
EQUIVALENCE(PROD1,PROD5)
                                                                   SUBROUTINE TO CALCULATE THE PARTIAL DERIVATIVES OF Q-DOT AND EVALUATE A CONSTANT DYNAMIC PRESSURE FLIGHT MODE CONSTRAINT
                                                 FLIGHT MODE CO
ENTRY ALTO20
ASSIGN 401 TO 160
ASSIGN 101 TO 18M
ASSIGN 201 TO 18M
ASSIGN 201 TO 18M
ASSIGN 401 TO 160
ASSIGN 101 TO 16M
ASSIGN 101 TO 16M
ASSIGN 101 TO 16M
ASSIGN 101 TO 16M
ASSIGN 10 TO 16M
ASSIGN 30 TO 16M
GO TO 301
ENTRY ALTO10
ASSIGN 40 TO 1GO
GO TO 301
ENTRY ALTO01
ASSIGN 40 TO 1GO
ASSIGN 40 TO 1GO
ASSIGN 50 TO 1GO
ASSIGN 60 TO 1GO
ASSIGN 60 TO 1GO
ASSIGN 60 TO 1GO
                                                                                                                                                                                                                                                                                                                                                        301-
                                                                                                                                                                                                                                                                                                                                                        301-
                                                                                                                                                                                                                                                                                                                                                         301-
                                                                                                                                                                                                                                                                                                                           ALT
ALT
ALT
ALT
ALT
ALT
                                                                                                                                                                                                                                                                                                                                                         301-
                                                                  PRELIMINARY CALCULATIONS ENTRY 60 ,30
  114.

115.

116.

117. C

118. C

120.

121.

122.

123.

123.

125. C

127. C

128.

129.

129.
                                   301 RDOT = V+ SINGAM

VDOT = R+OMEGAZ*COSRHO*(COSRHO*SINGAM - SINRHO*COSPSI*COSGAM)

+ - G*SINGAM + (T*CODAE - DB*COSA - DRAG)/M
                                                                                                                                                                                                                                                                                                                           AL7
                                                                                                                                                                                                                                                                                                                          PRELIMINARY CALC ENTRY 50 ,40 , 10, 20
                                 501 ROVAM = RO/M

TORO = 2.* RO

TOROR = 2.* ROR

TORORR= 2.* RORR

60 TO 160
                                PRELIMINARY CALC ENTRY 30 ,10

401 CSRNO = SINZRO/ Z.
CPSSAM= COSPSI+ COSGAM
CPSSGA= COSPSI+ SINGAM
SRNOZ = SINKHO+ SINGAM
SRNOZ = SINKHO+ SINGHO
CRNOZ = COSRNO+ COSRNO
ROMEG = R+ OMEGA
ROMEG2 = R+ OMEGA
COSRNO+ COSGAM
VOOTR = OMEGAZ+ COSRNO+ ( COSRNO+ SINGAM- SINKHO+ CPSGAM)

**
VOOTY = OMEGAZ+ COSRNO+ ( COSRNO+ SINGAM- SINKHO+ CPSGAM)
**
VOOTY = SINGAM
ROOTG = V+ COSGAM
VOOTG = ROMEGZ+ COSRNO+ ( CROGAM + SINKHO+ CPSSG
**
VOOTP = ROMEGZ+ COSRNO+ ( CROGAM + SINKHO+ CPSSG
**
VOOTP = ROMEGZ+ COSRNO+ ( CROGAM+ SINKHO+ CPSSG
**
VOOTO = -ROMEGZ+ ( SINZRO+SINGAM+ COSZRO+CPSGAM)
VOOTO = -ROMEGZ+ ( SINZRO+SINGAM+ COSZRO+CPSGAM)
PRELIMINARY COSCA
132.
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                                                                                                                                                                                                                                                                                                                           ALT
ALT
ALT
ALT
                                                                                                                                                                                                                       + SINRHO+ CPSSGA)
                                                                                                                                                                                                                                                                                                                           ALT
ALT
ALT
ALT
ALT
ALT
                          CCC
                                                                 PRELIMINARY CALCULATIONS TO 10
                                  101 VDRR = -
                                                                                                     GRR+SINGAM
                                                                                                                                                                      - ( DBRR+ CDSA+ DRAGRR )/ M
```

301-

```
VDRG = OMEGA2* COSRHO* ( CROGAM + SINRHO* CPSSGA)

** ORP - GH* COSGAM

** VDRP = OMEGA2* CSRHO + SINPSI* COSGAM

** VDRY = DRAGYR/M

** VDGP = ROMEG2 * COSRHO* ( COSRHO* SINGAM* SINRHO* CPSGAM)

** VDGP = ROMEG2 * CSRHO* ( PSGAM

** VDPP = ROMEG2 * CSRHO* ( PSGAM

** VDPP = ROMEG2 * CSRHO* CPSGAM

** VDDO = ROMEG2* COSZRO*SINPSI*COSGAM

** VDOO = ROMEG2*COSZRO*SINPSI*COSGAM

** VDOO = ROMEG2*2.*(COSZRO*SINGAM - SINZRO*CPSGAM)

** VDOO = ROMEG2*0.*(SINZRO*COSGAM - CDSZRO*CPSSGA)

** VDOO = ROMEG2*0.*(SINZRO*COSGAM - CDSZRO*CPSSGA)

** VDOO = DRAGY/M/M

** VDOO DRAGY/M/M

** ODA = ODA = DRAGY/M/M

** ODA = ODA = ODA = DRAGR/M/M

** ODA = ODA = ODA = DRAGR/M/M

** ODA = ODA =
         151.
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C-

167.

C

168.

C

171.

172.

173.
                                                                                                  PRELIMINARY CALCULATIONS ENTRY 20
                                                         201 VDOTT = CODAE/ M

VDOTDE= T+ SIDAE/ M

VOUTA = (-T+ SIDAE+ DB+ SINA- DRAGA )/ M

VDRA = - ( DRAGRA - DB+ SINA)/ M

VDOTMT= -CODAE/ M/ M

VDMDE = -VDOTDE/ M

VDMA =-VDOTA/M
      174.

175.

176.

177.

178.

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C C C

187.

C C

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C C

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199.
                                                                                                               CALCULATE MIXED SECOND ORDER PARTIALS
                                                                 20 XK3RT = TOROR= VDOTT

XK3RD = TOROR= VDOTDE

XK3RA = TOROR= VDOTA + TORO+ VDRA

XK3VA =-TORO+ DRACVA/M

XK3MT = TORO+ VDOTMT

XK3MD = TORO+ VDDE

XK3MA = TORO+ VDMA
                                                                                                              COMPUTE SECOND PARTIALS WITH RESPECT TO STATE
                                                              COMPUTE SECOND PARTIALS WITH RESPECT TO STATE

10 XK3RR = V+ ROOT+ RORRR+ 2 - (RORR+VDOT+TOROR+VDOTR+RO+VDRR)

XK3RV = TORORR+ ROOT- TOROR+ DRAGVY M- 2 - ROVRM+ DRAGVR

XK3RV = TOROR+ ROOT+ TOROR+ VDOTG+ TOROR+ VDRG

XK3VV = TOROR+ ROOT- 2 - ROVRM+ DRAGVY

XK3SV = ROR+ ROOTG+ V+ ROR+ COSGAM

XK3GC = N+V+ ROR+ SINGAM+ TORO+ VDGG

XK3PF = TORO+ VDPP

XK3PP = TORO+ VDPP

XK3PP = TORO+ VDPD

XK3OP = TORO+ VDPO

XK3OG = TORO+ VDOG

XK3OG = TORO+ VDOG

XK3OG = TORO+ VDOM

XK3MM = TORO+ VDMM

XK3MR = TORO+ VDMM

XK3MR = TORO+ VDMM

XK3MR = TORO+ VDMM
200.
201.
202.
203.
205. C
206. C
207. C
211.
212.
213.
214. C
215. C
216. C
                                                                                                           FIRST PARTIALS WITH RESPECT TO STATE
                                                               30 XK3R = V+ RDOT+ RORR+ TOROR+ VDOT+ TORO+ VDOTR

XK3V = TOROR+ RDOT- TORO/ M+ DRAGV

XK3G = V+ ROR+ RDOTG+ TORO+ VDOTG

XK3P = TORO+ VDOTP

XK3D = TORO+ VDOTO

XK3R = TORO+ VDOTM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             SECOND PARTIALS WITH RESPECT TO CONTROL

40 XK3TD = 2.* ROVRM* SIDAE

XK3TA = -XK3TD

XK3DD = -2.* ROVRM* T* CODAE

XK3DA = -XK3DD

XK3AA = -2.* ROVRM* ( T* CODAE- DB* COSA+ DRAGAA )
 218.
219.
220.
221.
222.
                                          000
    223.
224.
225.
                                                                                                       FIRST PARTIALS WITH RESPECT TO CONTROL
                                                               50 KKST = 2.+ ROVRM+ CODAE
```

```
6. XK3D = 2.* ROVRM* T* SIDAE
7. XK3A = 2.* ROVRM* ( DB* SINA~ T* SIDAE- DRAGA )
8. C
9. C
CONSTRAINT EVALUATION
0. C
1. 60 XK3 = V* RDOT* ROR* 2.* RO* VDGT
2. RETURN
3. END
```

F)

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORAGE BLOCK LOC	SUBROUTINE USAG SUBA CODE VAR
COBAE	cos(α-ξ _E)	i See sy⊕boi		/DYNA /(151	ALI I CODAE AL4 I CODAE AL6 I CODAE AL7 I CODAE AL9 I CODAE AL9 I CODAE APPLY I CODAE CONTRL I CODAE NLDRV I CODAE TH3 I CODAE UT O CODAE
COS A	C O S Œ	1 See symbol	·	/DYNA /(10) ALI I COSA AL9 I COSA AL9 I COSA AL6 I COSA AL8 I COSA AL8 I COSA APPLY I COSA CONTRL I COSA NLDRY I COSA OUTPUT I COSA TH3 I COSA UT M COSA
COSGAM		I See symbol	·	7) AL1
COSPSI	cos∳	I See symbol		/DYNA /(95	OUTPUT I COSGA POBCQL I COSGA STATEF M COSGA AL4 I COSPS AL8 I COSPS AL8 I COSPS AL9 I COSPS NLDRY I COSPS PDBCQL I COSPS STATEF O COSPS
COSRHO	c o s p	I See symbol		/DYNA /(97	AL4 I COSRM AL7 I COSRM AL8 I COSRM AL9 I COSRM AL9 I COSRM CONTRL I COSRM NUDRY I COSRM OUTPUT I COSRM PDBCQL I COSRM STATEF M COSRM
CO52RO	c o s 2 p	I See symbol		/DYNA /(120) AL4 I COS2RG AL7 I COS2RG AL8 I COS2RG NLDRV I COS2RG STATEF O COS2RG
DB	D _b	I Base drag		(LBS) /DYNA /(163	AL1 I DB AL4 I DB AL4 I DB AL6 I DB AL7 I DB AL8 I DB AL9 I DB AL9 I DB CONTRL I DB OUTPUT I DB STATEF I DB TH3 I DB

1

FORTRAN	MATH	CODE DESCRIPTION		STOR	AGE	SUBROUTINE USAGE
SYMBOL	SYMBOL	COR DESCRIPTION		BLOCK	LOC.	SUBR CODE VAR
DBR	aD _b ∕aR	1 See symbol		/DYNA /((86)	AL1 I DBR AL4 I DBR AL6 I DBR AL7 I DBR ALB I DBR AL9 I DBR STATEF I DBR TM3 I DBR UT I DBR
DBRR	∂ ² D ₆ /∂R²	I See symbol		/DYNA /(87)	AL4 I DBRR AL6 I DBRR AL7 I DBRR AL8 I DBRR AL9 I DBRR AL9 I DBRR STATEF I DBRR TH3 I DBRR UT I DBRR
DRAG	D .	I Aerodynamic drag	(LBS) -	/DYNA /(69)	AL5 I DRAG AL7 I DRAG AL8 I DRAG AL9 I DRAG APPLY I DRAG CONTRL I DRAG ENYPRO I DRAG NLDRY I DRAG OUTPUT I DRAG OUTPUT I DRAG
DRAGA	∂D/∂ ¤	1 See symbol .		/DYNA /(72)	UT M DRAG
DRAGAA	∂ ² D/∂ œ ²	I See symbol		/DYNA /(78)	
DRAGR	∂D/∂R	I See symbol		/DYNA /(71)	AL5 I DRAGR AL7 I DRAGR AL8 I DRAGR AL9 I DRAGR APPLY I DRAGR TH3 I DRAGR UT M DRAGR
DR A GRA	a ² D/aRa c	1 See symbol		/DYNA /(77)	ALI I DRAGRA AL5 I DRAGRA AL7 I DRAGRA AL8 I DRAGRA AL9 I DRAGRA APPLY I DRAGRA TH3 I DRAGRA UT M DRAGRA
DRAGRA	∂ ² D/∂R ²	I See symbol		/DYNA /(

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOC	ORA K	GE LOC	SUBROI SUBR	CODE	USAGE VAR
~			· · · · · · · · · · · · · · · · · · ·						
DRAGV	9D/9V	I See symbol		/DYNA	11	70)	AL5 AL7 AL8 AL9 APPLY TH3 UT] 1 1 1 1 1	DRAGY DRAGY DRAGY DRAGY DRAGY DRAGY
DRAGVA	a ² D/ava∝ 	i See symbol		/DYNA	/(75)	AL1 AL5 AL7 AL8 AL9 APPLY TH3 UT	I I I I I	DRAGYI DRAGYI DRAGYI DRAGYI DRAGYI DRAGYI DRAGYI
DRAGVR	∂ ² d/∂v∂R	I See symbol		/DYMA	/(74)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I I I	DRAGVE DRAGVE DRAGVE DRAGVE DRAGVE DRAGVE
DRAGVV	a ² D/av² -	1 See symbol	· · · _. · · ·	/DYNA	/(73)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I I I I	DRAGYN DRAGYN DRAGYN DRAGYN DRAGYN DRAGYN
6	9) Instantaneous	gravitational acceleration (FT/SEC ²)	/DYNA	/(8)	AL4 AL7 AL8 AL9 CONTRL NLDRY STATEF]]] .]	6 6 6 6 6 6 6
GH '	∂g/∂R	1 See symbol		/DYNA	/(142)	AL7 AL8 NLDRV STATER	I	6H 6H 6H
GAR	a²g/aR²	I See symbol		/DYMA	,	143)	AL7 AL8 NLDRY STATEF	i I	GRR GRR GRR GRR
•	,	I Mass	(6'S)	/0	//	97)	AL4 AL7 AL8 AL9 APPLY BRAPTE COSTAB COSTAB INTRPT NLTPUT SALATEF WRAPUP	I I I I I I I I	药药剂药剂药剂剂药剂剂药剂
DMEGA	•	1 Earth rotation	rate (RAD/SEC)	/DYMA		5)	AL4 AL7 CONTRL PDBCOL TRAJIN	1 1 1	OMEGA OMEGA OMEGA OMEGA OMEGA
DREGAZ	u 2	I See symbol		/DYNA	/(-6)		1 1 1 1	OMEGAZ OMEGAZ OMEGAZ OMEGAZ OMEGAZ OMEGAZ



FORTRAN SYMBOL	MATH Symbol	CODE	DESCRIPTION	DESCRIPTION			LOC	SUBROUTINE USAGE SUBR CODE VAR		
ħ	R	1	Radiai distance from earth center to wehic	le (FT)	/OYNA	/(71	AL4 I AL7 I ALB I CONTRL I ENVPRO I NLDRY I PDBCQL I QLTOSZ I STATEF M	R R R R R R	
RO	Pa	I	Atmospheric density (SLGS/FT ³)	/DYNA	/(15)	AL7 I AL8 I AL9 I NLDRY I OUTPUT I PDBCOL I STATEF I	RO RO RO RO RO RO	
ROR	∂ρ _∎ /∂R	1	See symbol		/DYNA	/(19)	AL7 I AL8 I AL9 I NLDRV I PDBCQL I STATEF I	ROR ROR ROR ROR ROR ROR	
RORR	∂ ² ρ₀/∂R ² 	1	See symbol		/DYNA		23)	AL7 I AL8 I AL9 I NLDRV I STATEF I	RORR RORR RORR RORR RORR	
RORAR	∂ ³ ρ _a /∂R ³	1	See symbol .		/DYNA	/(213)		RORRR RORRR RORRR RORRR	
SIDAE	s l n (α - δ _E)		See symbol		/DYNA	/(152)	AL1 I AL4 I AL6 I AL7 J AL8 I AL9 I APPLY I CONTRL I TH3 I UT O	SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE	
SINA	s i nα	Ī	See symbol		/DYNA	//	9)	ALI I AL4 I AL6 I AL7 I AL9 I AL9 I APPLY I CONTRL' I OUTPUT I TH3 I UT M	SINA SINA SINA SINA SINA SINA SINA SINA	
SINGAM	sin7	J	See symbol		/DYNA	/(SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM	

ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		STOR BLOCK	LOC'	SUBROUTINE USAGE SUBR CODE VAR
SIMPSI	sin∳	I See symbol			/DYMA /	(94)	AL4 I SINPSI AL7 I SINPSI AL8 I SINPSI AL9 I SINPSI CONTRL I SIMPSI NLORY I SINPSI POBCQL I SINPSI STATEF O SINPSI
S I NRHO	s i n p	I See symbol	-		/DYNA /	(96)	AL4 I SINRHO AL7 I SINRHO AL8 I SINRHO AL9 I SINRHO CONTRL I SINRHO OUTPUT I SINRHO OUTPUT I SINRHO STATEF M SINRHO
51 N2RO	sin2p	I See symbol			/DYNA /	(119)	
ī		1 Thrust		(LB\$)	/DYNA /	(42)	ALGCON PA T AL1 I T AL4 I T AL6 I T
	-	•	e e e e e e e e e e e e e e e e e e e	••••	 ,		ALT I T ALB I T ALB I T ALP I T APPLY I T APPLY I T CONTRL M I T I T APPLY I T T T ALP I T ALP
,	` v	I Relative veloci	ty.	(FT/SEC)	/0 /0	(91)	•

SUBRØUTINE AL8



Purpose

AL8 evaluates the heating rate constraint, Equation 10.6-2 in Vol. I. In addition, it computes the explicit first and second partials of this constraint with respect to the state and control as they are needed.

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ALB
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                  SUBROUTINE ALS
                        SUBROUTINE TO CALCULATE THE PARTIAL DERIVATIVES OF Q-DOT-DOT AND EVALUATE A CONSTANT HEATING RATE FLIGHT MODE CONSTRAINT
              REAL_MAGBY, MU, M, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM
DYNA
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                                                                                                                                                                                                                                                                    ALB
ALB
ALB
ALB
                                                                                                                                                                                                                                                                                             601-
                                                      PRELIMINARY CALCULATIONS FOR ENTRY 60
                                                                                                                                                                                                                                                                    ALB
                                      ROOT = V* SINGAM
R6R = ROR/6.3
R6RR = RORR/6.3
R6RRR = RORR/6.3
V115 = V**1.15
CSRNO = SINZRO /2.
CPSGAM = COSPSI* COSGAM
CPSSGA = COSPSI* SINGAM
ROMEG2 = R* OMEGA2
CROGGM = COSRNO* COSGAM
CROSGA = COSRNO* COSGAM
VDOT = ROMEG2 + COSRNO* ( CROSGA — SINRNO* CPSGAM
VDOT = ROMEG2 + COSRNO* ( T* CODAE - DB + COSA - DRAG) / M
 114.
115.
116.
117.
118.
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121.
                            601 ROOT
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137.
                     CCC
                                                      PRELIMINARY CALCULATIONS FOR ENTRY 20
                          201 VDRA = (DBR+ SINA - DRAGRA)/ M

VDVA = - DRAGVA/ M

VDMT = - CODAE/A/M

VDMD = - T+ SIDAE/A/M

VDMA = (T+ SIDAE - DB+ SINA + DRAGA)/M/M
                                               PRELIMINARY CALCULATIONS FOR ENTRY 10
                                                          RELIMINARY CALCULRITIONS FOR EMINY 19

= - GRR *SINGAM - (DBRR* COSA + DRAGRR)/M
= - ORAGYR/M
= OMEGA2* COSRHO*(CROGAM + SINHO* CPSSGA) - GH*COSGAM
= OMEGA2* CSRHO* SINPSI*(OSGAM
= - OMEGA2* SINZRO* SINGAM + COS2RO* CPSGAM)
= (DBR* COSA + DRAGR)/M/M
= - ORAGYV/M
= DRAGYV/M
= ORAGYV/M
- ROMEG2* COSRHO*(CROSGA-SINRHO*CPSGAM)+ G* SINGAM
= - R* VDR*SINGAM/COSGAM
= - ROMEG2 *(SINZRO * COSGAM - COS2RO*CPSSGA)
= ROMEG2 * COSGAM* SINPSI* COS2RO
138.
139.
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146.
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148.
149.
150.
                           101 VDRR
                                        VORV
VORG
VORP
VORO
VORM
VOVV
VOVM
                                         VD66
VD6P
VD6D
VDPO
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VDPP = ROMEG2*CSRHO+CPSGAM
VD00 = -2.*ROMEG2*(COS2RO+SINGAM - SIN2RO+CPSGAM)
VDMM = 2.*(T*CODAE - DB*COSA - DRAG)/M**3
    1151.
    152.

153.

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                                                                                                     PRELIMINARY CALCULATIONS FOR ENTRY 30 ,20 ,10
                                                  301 VDOTR = DMEGA2* COSRHO*( CROSGA - SINRHO* CPSGAM) -
GH* SINGAM - ( DBR* COSA + DRAGR)/ M
RDOTV = SINGAM
VDOTV = DRAGV/ M
RDOTG = V* COSGAM
VDOTG = ROMEG2* COSRHO*( CROGAM+ SINRHO* CPSSGA)- G* COSGAM
VDOTD = ROMEG2* CSRHO + SINPSI* COSGAM
VDOTD = ROMEG2* C2.*CSRHO * SINGAM + COS2RO* CPSGAM)
VDOTM =-(T*CODAE - DB* COSA - DRAG)/M/M
                                        CCC
                                                                                     PRELIMINARY CALCULATIONS FOR ENTRY 40
                                                  401 VDTD = SIDAE/M

VDTA = - VDTD

VDDD = - T+CDDAE/M

VDDA = - VDDD -( DB+ COSA + DRAGAA)/ M
                                       CCC
                                                                                   PRELIMINARY CALCULATIONS FOR ENTRY 50
                                                501 VDOTT = CODAE/M
VDOTD = T+ SIDAE/ M
VDOTA = -VDOTD +(DB+ SINA - DRAGA)/M
GO TO IGO
                                                                                                    CALCULATE MIXED PARTIALS
  183.

184.

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2001.

2002.

2005.

2007.
                                                         20 XK3RT = ROR+ VDOTT

XK3RD = ROR+ VDOTD

XK3RA = ROR+ VBOTA+ RO* VBRA

XK3VA = RO* VDVA

XK3RT = RO* VDMT

XK3RD = RO* VDMD

XK3MA = RO* VDMA
                                                                                        CALCULATE SECOND PARTIALS WITH RESPECT TO STATE
                                                       CALCULATE SECOND PARTIALS WITH RESPECT TO STATE

10 XK3RR = RORR + VDOTY+ ROP VDRY+ROP VDRRY11>*RORRR*RDOT

XK3RV = ROR + VDOTY+ ROP VDRY+RORRR*V115*SINGAM*2.15

XK3RC = ROR + VDOTG+ ROP VDRY

XK3RC = ROR + VDOTTO+ ROP VDRY

XK3CV = V115*RORM*ROR*V115/V+RO*VDVY

XK3CV = V115*ROR*ROP VDRY

XK3CV = V115*ROR*ROOT + ROP VDGG

XK3CC = ROP VDCC

XK3CC = ROP VDCC
   208.
209.
210.
211.
212.
                                                                                 CALCULATE FIRST PARTIALS WITH RESPECT TO STATE
                                                       30 XK3R = ROR* VDOT+ RO* VDOTR+V115*R6RR*RDOT

XK3V = V115*R6R*2.15*SINGAM*RO*VDOTV

XK3G = V115*R6R*RDOTG + RO*VDOTG

XK3P = RO* VDOTP

XK3O = RO* VDOTO

XK3M = RO* VDOTM
213.
214.
215.
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220.
221.
222.
223.
224.
225.
                                                                                           CALCULATE SECOND PARTIALS WITH RESPECT TO CONTROL
                                                        40 XK3TD = R0=VDTD

XK3TA = R0=VDTA

XK3DD = R0=VDDD

XK3DA = R0=VDDA
```

AL8 AL8 AL8 AL8

AL8 AL8 AL8

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226. XK3AA = RO+VDAA

227. C
228. C
229. C
230. 50 XK3T = RO+ VDOTT
231. XK3D = RO+ VDOTD
232. XK3A = RO+ VDOTA
232. XK3A = RO+ VDOTA
233. C
234. C
235. C
236. 60 XK3 = V115+RDOT+R6R + RO+VDOT
237. RETURN
END
```



FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	S10 BLOCK	RAGE LOC	SUBROUTINE USAGE SUBR CODE VAR		
CODAE	cos(α-6 _E)	i See symbol		/DYNA	/(151)	AL1 I CODAE AL4 I CODAE AL6 I CODAE AL7 I CODAE AL8 I CODAE AL9 I CODAE APPLY I CODAE CONTRL I CODAE NLDRY I CODAE TH3 I CODAE UT O CODAE		
COSA	C O S Q	l See sy abol	- -	/ DYMA	/(10)	AL1 I COSA AL4 I COSA AL6 I COSA AL7 I COSA AL8 I COSA AL9 I COSA APPLY I COSA CONTRL I COSA CONTRL I COSA OUTPUT I COSA OUTPUT I COSA OUTPUT M COSA		
 COS GAM	C 0 8 7	1 See symbol	• • • • • • • • • • • • • • • • • • •	/DYNA		ALI I COSGAP AL4 I COSGAP AL7 I COSGAP AL8 I COSGAP AL9 I COSGAP CONTRL I COSGAP NUDRY I COSGAP DUTPUT I COSGAP PDBCQL I COSGAP STATEF M COSGAP		
COSPSI	c o s♥	I See symbol		/DYNA	/(95)	AL4 I COSPSI AL7 I COSPSI AL8 I COSPSI AL9 I COSPSI CONTRL I COSPSI PDBCQL I COSPSI PDBCQL I COSPSI STATEF O COSPSI		
COSRMO	C 0 3 p	1 See symbol		/DYNA	/(97)	AL4 I COSRNO AL7 I COSRNO AL8 I COSRNO CONTRL I COSRNO CONTRL I COSRNO OUTPUT I COSRNO PDBCQL I COSRNO STATEF M COSRNO		
COSZRO	c o s 2 p	I See symbol	•	/DYNA /	(120)	AL4 I C052R0 AL7 I C052R0 AL8 I C052R0 NLDRV I C052R0 STATEF O C052R0		
ga ·	D	I Base drag	·	(LBS) /DYNA /				

FORTRAN Symbol	MATH Symbol	MATH CODE DESCRIPTION				SUBROUTINE USAGE SUBR CODE VAR		
DBR	∂D _b /∂R	I See symbol		/DYNA /C	86)	AL1 I OBA AL4 I DBR AL6 I DBR AL7 I OBR AL8 I DBR AL9 I DBR APPLY I DBR STATEF I DBR TH3 I DBR UT I DBR		
DBRR	∂ ² D ,/∂R ²	I See symbol		/DYNA /(87)	AL4 I DBRR AL6 I DBRR AL7 I DBRR AL8 I DBRR AL9 I DBRR APPLY I DBRR STATEF I DBRR TH3 I DBRR UT I DBRR		
DRAG		I Aerodynamic drag	(LBS)	/DYNA /(69)	AL5 I DRAG AL7 I DRAG AL8 I DRAG AL9 I DRAG CONTRL I DRAG ENVPRO I DRAG MLDRV I DRAG OUTPUT I DRAG OUTPUT I DRAG TH3 I DRAG UT DRAG		
DRAGA	∂D/∂œ	1 See symbol		/DYNA /(72)			
DRAGAA	∂ ² D/∂∝ ²	I See symbol		/DYNA /(78)	AL1 I DRAGA AL5 I DRAGA AL7 I DRAGA AL8 I DRAGA AL9 I DRAGA APPLY I DRAGA APPLY I DRAGA TH3 I DRAGA UT M DRAGA		
DR A GR	∂D/∂R	1 See symbol		/DYNA /(71)	ALS I DRAGR AL7 I DRAGR AL8 I DRAGR AL9 I DRAGR APPLY I DRAGR TH3 I DRAGR UT M DRAGR		
ORAGR a	a ² D/aRa∝	1 See symbol		/DYNA /C	77)	AL1 I DRAGR AL5 I DRAGR AL7 I DRAGR AL8 I DRAGR AL9 I DRAGR APPLY I DRAGR APPLY I DRAGR TM3 I DRAGR UT M DRAGR		
DRAGRR	∂ ² D/∂R ²	I See symbol		/DYNA /(76)	ALS I DRAGR AL7 I DRAGR AL8 I DRAGR AL9 I DRAGR APPLY I DRAGR TH3 I DRAGR UT M DRAGR		



FORTRAN SYMBOL	MATH Symbol	CODE	DESCRIPTION		8LOC	CRAS K	LOC	SUBFOU SUBR	TINE U	SAGE VAR
DRAGV	9D/8V	1 See symbol	•		/DYNA	/(70)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DR I DR I DR I DR	464 1464 1464 1464 1464
DRAGVA	a ² D/ava∝	l See symbol			/DYNA	11	75)	ALI AL5 AL7 AL8 AL9 APPLY TH3	I DA I DA I DA I DA I DA	AGVA AGVA AGVA AGVA AGVA AGVA
DR A G VR	a²d∕avaR	l See symbol			/DYNA	/(74)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DR I DR I DR I DR	AGVR AGVR AGVR AGVR AGVR AGVR
DRAGVV - ·	a ² D/av ²	l See symbol	-		/DYNA		73)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DR I DR I DR I DR	4644 4644 4644 4644 4644 4644
	9	I Instantanco	us gravitational acceleration	(FT/SEC ²)	/DYNA	/(. 8)	AL4 AL7 AL8 AL9 CONTRL NLDRV STATEF	1 6 1 6 1 6 1 6 1 6	
GH	∂g/∂R	I See symbol			/DYNA	/(142)	AL7 AL8 ALDRY STATEF	I 6M I 6M I 6M	
GRA	a²g/aR²	I See symbol			/DYNA	/(143)	AL7 AL8 NLDRV Statef	I GR	R R
	•	I Mess		(6 [°] 5)	/D	/(97)	AL7 AL8 AL9 BRANPT COSTAB COSTAI IMTRPT NLDRY OLDRY OSTATEF		
DMEGA2	w²	1 See symbol			/DYNA	/(AL4 AL7 AL8 AL9	I OMI I OMI I OMI I OMI I OMI	EGAZ EGAZ EGAZ EGAZ EGAZ EGAZ

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOC	T OR A	GE LOC	SUBROUT SUBA C	INE USAGE ODE VAR
R	R	ī	Radial distance from earth center to vehicle (FT)	/DYNA	/(7)	AL7 AL8 AL9 CONTRL ENVPRO	I R
RÓ	Pe		Atmospheric density (SLGS/FT ³)	/DYNA	/(15)		I AD I RO I RO I RO I RO
ROR	∂ <i>p</i>	1	See symbol	/DYNA	/(19)	ALT I ALB I AL9 I NLDRV I PDBCQL I STATEF I	ROR ROR ROR ROR
RORR	∂ ² ρ _a /∂R ²	1	See symbol	/DYNA	/(23)	AL7 1 AL8 1 AL9 1 NLDRV 1 STATEF 1	RORR RORR RORR
RORRA	θ ³ ρ _a / θR ³	1	See symbol	/DYNA	/Ċ	213)		RORRR RORRR RORRR
SIDAE	sin(α-6 _E)	1	See symbol	/DYNA		152)	AL1 II AL4 II AL6 II AL7 II AL8 II AL9 II APPLY II CONTRL II TH3 III	SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE
SINA	s i n∝	i	See symbol	/DYNA	/(AL1 II AL4 II AL6 II AL7 II AL9 II AL9 II APPLY I CONTRL I OUTPUT I TH3 II UT	5 I NA 5 I NA
SINGAM	sln7	1	See symbol	/DYNA	/(ALI I AL4 I AL7 I AL7 I AL9 I CONTRL I NLORV I POBCOL I STATEF M	SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM

FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION		ST BLOCK	ORAGE LOC	SUBROUTINE USAGE SUBR CODE VAR
SINPSI	sinv∕	I See symbol		/DYNA	/(94)	AL4 I SINPSI AL7 I SIMPSI AL8 I SIMPSI AL9 I SIMPSI CONTRL I SIMPSI MLDRY I SIMPSI PDBCQL I SIMPSI STATEF O SIMPSI
SINRHO	s i n p	I See symbol		/DYNA	/(96)	AL4 I SINRHO AL7 I SINRHO AL8 I SINRHO CONTRL I SINRHO OUTRL I SINRHO OUTPUT I SINRHO OUTPUT I SINRHO OTTUTE I SINRHO STATEF M SIKSHO
SINZRO	sin2p	I See symbol .		/DYNA	/(119)	AL4 I SIN2RO AL7 I SIN2RO AL8 I SIN2RO NLDRV I SIN2RO STATEF M SIN2RO
T -	Ţ	I Threst	(LBS)	/DYNA	• 	ALGCON M T AL1 I T AL4 I T AL6 I T AL7 I T AL8 I T AL9 I T APPLY I T APPLY I T APPLY I T T APPLY I T T AT
•	v	I Relative velocity.	(FT/SEC)	/8	, 91)	ALI I V ALA II V ALA II V ALB II V ALB II V BCOND I MOM BNDRY O MOM BNDRY O MOM CONTRL I V ENOPT I MOM CONTRL I V ENOPT I WOM INTERP M MOM INTERP M MOM NLDRY O NOM NLDRY O NOM OUTPUT I V PDBCDL I V STATEF I V WRAPUP I V

SUBRØUTINE AL9

Purpose

AL9 evaluates the Reynolds number rate constraint, Equation 10.6-3 in Vol. I. In addition, it computes the explicit first and second partials of this constraint with respect to the state and control as they are needed.

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M
M
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SUBROUTINE ALT
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                                                                                                                                                                                                                                         SUBROUTINE TO CALCULATE THE PARTIAL DERIVATIVES OF REYNOLDS NUMBER-DOT AND EVALUATE A CONSTANT REYNOLDS NUMBER FLIGHT MODE CONSTRAINT
                                                                                                                                                 REYNOLDS NUMBER FLIGHT MODE CONSTRAINT

REAL MAGBY, MU, M, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM

LHT
COMMON /D/

**X, M, XI(4), MAGBY, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI,
**ALT, RHO, MU, M, TAU, MT, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU,
**LHT D109 D110 BV(40), ZSAVE(20), D1(20), NPOINT(20), DELT(20)

DIMENSION MOM(20)
EQUIVALENCE (NOM, V)
LOGICAL SWITCH, 100AD
REAL MACH, ISP, ISPV, ISPR, ISPM, ISPT, ISPV, ISPVR, ISPVR,
**LIFTR LIFTA, LIFTVY, LIFTVR, LIFTVA, LIFTRR, LIFTA, MUR, LIFTAA,
**LIFTR LIFTA, LIFTVY, LIFTVR, LIFTVA, LIFTRA, COMMON /DVAA/
**X, TIME, SINGAM, COSGAM, OMEGA, OMEGA2, R, G, SINA,
**COSA DYMOI1 DMEGAT TAMP, PA, RO, CS, TEMPR, PAR,
**COSA DYMOI1 DMEGAT TAMP, PA, RO, CS, TEMPR, PAR,
**COSA DYMOI1 DMEGAT TAMP, PA, RO, CS, TEMPR, PAR,
**COSA DYMOI1 DMEGAT TAMP, PA, RO, CS, TEMPR, PAR,
**COSA DYMOI1 DMEGAT TAMP, PA, RO, CS, TEMPR, PAR,
**COSA DYMOI1 DMEGAT TAMP, PA, RO, CS, TEMPR, PAR,
**COSA DYMOI1 DMEGAT TAMP, PA, RO, CS, TEMPR, PAR,
**COSA DYMOI1 DMEGAT TAMP, PAR,
**COSA DWAGIT, TAMP,
**COSA DWAGIT, TAMP, PAR,
**COSA DWAGIT, TAMP, PAR,
**COSA DWAGIT, TAMP, PAR,
**COSA DWAGIT, TAMP, PAR,
**COSA DWAGIT, TAMP,
**COSA DWAGIT, TAMP,
**COSA DWAGIT, TAMP,
**COSA DWAGIT, TAMP,
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DYNA
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DYNA
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                                                                                                                                         **FVACT FVACVY FVACVR FVACRR FVACTT T MACHW MACHR ISPR
**ISPR** ISPR** ISPM** ISPM** ISPW** ISPW** ISPW** ISPW** ISPM** ISPM*** I
     38.
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     49.
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561.
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664.
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                                                                                                                                                                                                                                                                                                                                                                                                                                                              XKIMA XK2MA
XK12M XK22M
XK12M XK22M
XK1UV XK2UV
XK1UV XK20G
XK10G XK20G
XK10G XK20G
XK10F XK20G
XK10P XK20P
XK12P XK22P
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        , x x 3 A 

, x x 3 P v 

, x x 3 G 

, x x 3 G 

, x x 3 C 

, x x 3 C 

, x x 3 C 

, x x 3 C 

, x x 3 C P 

, x x 3 Z P
                                                                                                                                                                                                                                                       , XX 200
, XX 204
, XX 204
, XX 276
, XX 276
, XX 276
, XX 276
                                                                                                                                                                                                                                                                                                                                                          , XK3MD
, XK3CV
, XK3CV
, XK3ZV
, XK3RG
, XK3RG
, XK3RP
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XK3RV
XK3PG
XK3PG
XK3PP
XK3PP
XK3PP
                                                                                                                                                 XKIRV
XKIRV
XKIPV
XKIPP
XKIPP
XKIPP
XKIPP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            , XK2RV
, XK2RV
, XK2PG
, XK2UG
, XK2PP
, XK2UP
, XK2RR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 MATS
MATS
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MATS
MATS
MATS
MATS
69.
70.
71.
72.
73.
74.
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MATS
MATS
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MATS
MATS
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ALL99

ALL99
                                     EQUIVALENCE (PRODI

ENTRY AL9020

ASSIGN 10-TO IAM

ASSIGN 1 TO 1GO

GO TO 6

ENTRY AL9011

ASSIGN 2 TO IGO

GO TO 6

ENTRY AL9010

ASSIGN 30 TO IAM

ASSIGN 30 TO IAM

ASSIGN 40 TO IAM

ASSIGN 40 TO IAM

ASSIGN 4 TO IGO

GO TO 6

ENTRY AL9002

ASSIGN 4 TO IGO

GO TO 6

ENTRY AL9001

ASSIGN 5 TO IGO

GO TO 6

ENTRY AL9000

ASSIGN 5 TO IGO

GO TO 6

ENTRY AL9000

ASSIGN 5 TO IGO

GO TO 6
                   C
   103.
 105.
106.
107.
 108.
109.
110.
 iiā.
                                                          = V+ SIMGAM

= R+ DMEGAZ+ COSRHO+(COSRHO+ SINGAM- SINRHO+ COSPSI+ COSGAM

)- G+ SIMGAM+ (T+ CODAE- DB+ COSA- DRAG)/ M

= RHO+ UMU/ V

= UMU+ ROR - UMUI+ RO

= CZ/ V
114.
115.
116.
117.
118.
119.
                                                                                                                                                                                                                                                     VDOT
                                      Cı
                                      C2 = C
C3 = C
GO TO 160
 120.
121.
122.
123.
124.
125.
126.
127.
128.
129.
                               1 CONTINUE

VDOTT = CODAE/M

VDVA = - DRAGVA/M

VDRA = -(DRAGRA - DBR* SINA)/M

F1 =(ROR* UMU + UMU1*RO)/V
                                                       2 VDRR
VDRG
                                      VDRP
B1
B2
                                      B2
VDRG
VDRM
VDGG
VDGP
B3
VDGO
136.
137.
138.
139.
141.
142.
143.
144.
146.
147.
149.
                                      VDPP
B22
VD00
                                      VDAM
                                                           = COSRHO+ SINGAM- SINRHO+ COSPSI+ COSGAM
= COSRHO+ COSGAM+ SINRHO+ COSPSI+ SINGAM
= SINRHO+ SINGAM+ COSRHO+ COSPSI+ COSGAM
= OMEGA2+ COSRHO+ AI+ G+ SINGAM/R -(URAGR+ DBR+ COSA)/M
                                       VDOTR
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VDOTV = - DRAGY/ M

VDOTG = R* DREGA2* COSGAM* A2 - G* COSGAM

VDOTM =-R* OMEGA2*(A1+ A3)

VDOTM =-(T* CODAE- DB* COSA - DRAG)/ M
 151.
152.
153.
154.
155.
156.
157.
158.
159.
160.
                      4 CONTINUE
             C
                      5 C4 = C1/M
60 TO IAM
                                  CALCULATE MIXED PARTIALS
 162.
163.
164.
165.
166.
167.
168.
169.
170.
171.
                   10 XK3RT = VDOTT=F1

XK3RD = VDOTD=F1

XK3RA = VDOTA=F1 + C1= VDRA

XK3VT = -C1/V= VDOTD

XK3VA = -C1/V= VDOTD

XK3VA = -C1/V= VDOTA + C1= VDVA

XK3MD =-C4 = VDOTA

XK3MA =-C4 = VDOTA
 173.
174.
175.
176.
                                  CALCULATE SECOND PARTIALS WITH RESPECT TO STATE
                   189.
191.
191.
192.
193.
194.
195.
196.
197.
198.
199.
200.
202.
203.
                                 CALCULATE FIRST PARTIALS WITH RESPECT TO STATE
                                       = RDOT=(UMU=RORR-RO=UMU1)+VDOT/V=(ROR=UMU+UMU1=RO)+C1=VDOTR
= C2+ SINGAM - C1/V= VDOT + C1+ VDOTV
= C2+ V+ COS6AM+ C1+ VDOT6
= C1+ VDOTP
= C1+ VDOTM
                        XK3R
XK3V
XK3G
XK3P
XK3O
XK3M
204.
205.
206.
207.
208.
209.
211.
212.
213.
214.
215.
216.
217.
219.
220.
221.
222.
                                 CALCULATE SECOND PARTIALS WITH RESPECT TO CONTROL
                   40 XK3TO = C4+ SIDAE

XK3TA = - XK3TD

XK3DA = C4+ T+CODAE

XK3DD = - XK3DA

XK3AA = C4+ (DB+ COSA - T+ CODAE- DRAGAA)
                                 CALCULATE FIRST PARTIALS WITH RESPECT TO CONTROL
                   50 1K3T = C4 + CODAE

1K3D = C4 + T+ SIDAE

1K3A = C4 + (DB+ SINA- T+ SIDAE- DRAGA)
                                 CALCULATE CONSTRAINT
                        153
Return
End
                                      = C2+ RDOT + C1+ VDOT
```

FORTRAN	MATH	COD	E	DESCRIPTION		51	ORA		SUBROL	TINE	USAGE
SYMBOL	SYMBOL		· · · · · · · · · · · · · · · · · · ·	. DESCRIFTION		BLOC	K	FOC.	SUBR	CODE	VAR
CODAE	cos(α-δ _Ε)	1	See symbol			/DYNA	/(151	AL1 AL4 AL6 AL7 AL8 AL9 APPLY CONTRL NLDRY TH3 UT	1 1 1 1 1 1 1 1	CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE
- -	C O S &	I	See symbol			/DYNA	/(10)	AL1 AL6 AL7 AL8 AL9 APPLY CONTRL NLDRY OUTPUT TH3 UT	I I I I	COSA COSA COSA COSA COSA COSA COSA COSA
COSGAM	C017 		See symbol		-	/DYNA			AL1 AL4 AL7 AL8 AL9 CONTRL]]]]	COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM
COSPSI	. '	1	Saa awahat	. ,		/BYNA	/(QE \	NLDRY OUTPUT PDBCQL	J I I	COSGAM COSGAM COSGAM COSGAM COSPSI
ouar a I	.cos v	•	See symbol			/ DT RR	,,	721	AL7 AL8 AL9 CONTRL NLDRY PDBCOL STATEF	! ! ! ! !	COSPSI COSPSI COSPSI COSPSI COSPSI COSPSI COSPSI
COSAHO	CO\$P ,	. 1.	See symbol			/DYNA	/(97)	AL4 AL7 AL8 AL9 CONTRL NLDRY OUTPUT PDBCOL STATEF	I I I I I I	COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO
OB	0,	1	Base _, dr ag		(LBS)	/ DYNA	/(163)	AL4 AL6 AL7 ALB AL9 APPLY CONTRL NLDRV		08 08 08 08 08 08 08 08 08 08

FORTRAN SYMBOL	MATH Symbol	CODE DESCRIPTION	SIDRAGE SUBROUTINE USAGE BLOCK LOC SUBR CODE VAR
DBR	aD _b ∕aR	See symbol .	/DYNA /(86) AL1 I DBR AL4 I DBR AL6 I DBR AL7 I DBR AL8 I DBR AL8 I DBR AL9 I OBR APPLY I DBR STATEF I DBR TM3 I DBR UT I DBR
DBRR —	a ² D _b ∕aR²	I See symbol	/DYNA /(87) AL4 I DBRR AL6 I DBRR AL7 I DBRR AL8 I DBRR AL9 I DBRR APPLY I DBRR STATEF I DBRR TM3 I DBRR UT I DBRR
DRAG	D	I Aerodynamic drag	(LBS) /DYNA /(69) AL5 I DRAG AL7 I DRAG AL8 I DRAG AL9 I DRAG APPLY I DRAG CONTRL I DRAG ENVPRQ I DRAG NLDRY I DRAG OUTPUT I DRAG TH3 I DRAG UT M DRAG
DRAGA	∂D/∂ œ	I See symbol .	/DYNA /(72) AL1 I DRAGA AL5 I DRAGA AL7 I DRAGA ALB I DRAGA ALB I DRAGA AL9 I DRAGA AL9 I DRAGA APPLY I DRAGA TH3 I DRAGA UT R DRAGA
DRAGAA	∂ ² D/∂ œ ²	1 See symbol .	/DYNA /(78) AL1 I DRAGAA AL5 I DRAGAA AL7 I DRAGAA AL8 I DRAGAA AL9 I DRAGAA APPLY I DRAGAA TH3 I DRAGAA UT A DRAGAA
DRAGR	∂D/∂R	1 See symbol	/DYMA /(71) ALS I DRAGR AL7 I DRAGR AL8 I DRAGR AL9 I DRAGR APPLY I DRAGR TH3 I DRAGR UT M DRAGR
DRAGRA	a ² D/aRa∉	I See symbol	/DYNA /(77) AL1 I DRAGRA AL5 I DRAGRA AL7 I DRAGRA AL8 I DRAGRA AL9 I DRAGRA APPLY I DRAGRA TH3 I DRAGRA UT M DRAGRA
DRAGRA	a ² 0/aR ²	1 See symbol	/DYNA /(76) AL5 I DRAGRR AL7 I DRAGRR AL8 I DRAGRR AL9 I DRAGRR APPLY I DRAGRR TH3 I DRAGRR UY M DRAGRR



FORTRAN	MATH	CODE	DESCRIPTION	S1 BLOC	TORAGE	nc .	SUBROU	TINE	JSAGE
SYMBOL	SYMBOL		DESCRIPTION	BLOC	K L	0 C	S USTR	CODE	VAR
DRAGV	∂ D/ ∂V .	I See symbol		/DYNA	/(70)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DI I DI I DI I DI	RAGV RAGV RAGV RAGV RAGV RAGV
DRAGVA	a²D/ava∝	I See symbol	· · · · · · · · · · · · · · · · · · ·	/DYNA	16	75)	ALI AL5 AL7 AL8 AL9 APPLY TH3 UT	I DI I DI I DI I DI I DI	14348 14348 14348 14348 14348 14348
DRAGVR	a ² d/avaR	I See symbol		/DYNA		74)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DF I DF I DF I DF	RAGVR RAGVR RAGVR RAGVR RAGVR
DRAGVV -	a ² D/av ²	i See symbol		/DYNA		73)	AL7 AL8 AL9 APPLY	I DF I DF I DR I DR	1 A G V V 1 A G V V 1 A G V V 1 A G V V 1 A G V V
.	g	I Instantaneous	gravitational acceleration (FT/SEC ²)	/DYNA	/(8)	AL4 AL7 AL8 AL9 CONTRL	I 6 I 6 I 6 I 6 I 6 I 6 I 6	
A	•	l Mass	(6'5)	/0		97)	AL7 AL8. AL9 APPLY BRANPT COSTAB COSTAI INTRPT NLDRY OUTPUT SALVE STATEF	I A	
OMEGA2	u ²	1 See symbol		/DYNA	/(AL4 AL7 AL8 AL9 NLDRV TRAJIN	1 0F 1 0F 1 0F 1 0F	IEGA2 IEGA2 IEGA2 IEGA2 IEGA2 IEGA2
R	R	I Radial distanc	e from earth center to vehicle (FT)	/DYNA	/(AL4 AL7 AL8 AL9 CONTRL ENVPRO NLDRV PDBCQL GLTOSZ STATEF	I R I R I R	

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		S1 BLOC	ORA	LOC	SUBROUT SUBR C	INE USAGE ODE VAR
RHO	P	I Latitude		(RAD)	/D .	и	95)	BUTPUT	I RHO I RHO I RHO I RHO
RO	Pa	I Atmospher	ic density	(SLGS/FT ³)	/DYNA	/(15)	AL7 ALB AL9 NLDRV OUTPUT	I RO I RO I RO I RO I RO I RO
ROR	∂ ρ ૄ/∂R	I See symbo	• •		/DYNA	/(19)	AL8 AL9	I ROR I ROR I ROR I ROR I ROR I ROR
RORR	∂ ² ρ _e /∂R ²	I See symbo	1		/DYNA	/(23)	AL8	I RORR I RORR
RORRR	∂ ³ ρ _• /∂R ³	1 See symbo			/DYNA	/(213)	AL7 I AL8 I AL9 I STATEF I	RORRR
SIDAE	sin(α-ξ _E)	I See symbo	<u> </u>	÷	*/DYNA		152)	ALI I AL4 I AL6 I AL7 I AL8 I AL7 APPLY I CONTRL I TH3 I UT	SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE SIDAE
SINA	s i n a	I See symbo	1		/DYNA		9)	ALI 1 AL4 I AL6 I AL7 I AL8 I AL9 I AL9 I CONTRL I CONTRL I TH3 I UT	SINA SINA SINA SINA SINA SINA SINA SINA
SINGAM	-sín7	I See symbo	1	s	/DYWA	K		ALI II AL4 II AL7 II AL8 II AL9 II CONTRL II NLDRV II POBCQL II STATEF M	SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM SINGAM
S1 MP S 1	sin∳	I See symbo	ı		/DYNA	/(AL4 I AL7 I AL8 I AL9 I CONTRL I NLDRY I PDBCQL I STATEF O	SINPSI SINPSI SINPSI SINPSI SINPSI SINPSI

FORTRAM SYMBOL	MATH Symbol	CODE	DESCRIPTION		ST BLCC	ORA(LOC	SUBROUTI SUBR CO	NE USAGE DE VAR
SINRHO	s i n <i>p</i>	l See symbol			/DYNA	/(96)	AL4 I AL7 I AL8 I AL9 I CONTRL I NLORY I OUTPUT I OUTPUT I STATEF M	SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO
	T	I Thrust		(LB\$)	/DYNA	/(42)	ALGCON MALL I I AL4 I AL6 I AL7 I AL9 I AC7 I O CONTRL M DL2 I I MPPULS I I MPPULS I I TH1 I TH2 I TH3 I TH4 I I I I I I I I I I I I I I I I I I I	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
v	-	1 Relative ve	locity.	(FT/SEC)	/D	16	91)	AL1 I AL4 I AL7 I AL8 I AL9 I BOONTY O CONTRL I ENUPPE I FETCH O INTERP MINDRY ONLORY OUTPUT I POBCOL I WRAPUP I WRAPUP I	A A A M M M M M M M M M M M M M M M M M

ANL62S computes the atmospheric properties T_a , P_a , ρ_a and c_s for the '62 Standard atmosphere. Moreover, when the Reynolds number rate constraint is in effect, it computes the atmospheric viscosity ν . In addition, the following derivatives are computed:

$$\frac{dT_a}{dh}$$
, $\frac{dP_a}{dh}$, $\frac{d\rho_a}{dh}$ and $\frac{dc_s}{dh}$

and

$$\frac{d^2T_a}{dh^2}$$
, $\frac{d^2P_a}{dh^2}$, $\frac{d^2\rho_a}{dh^2}$ and $\frac{d^2c_s}{dh^2}$

and, if any SVIC's are in effect

$$\frac{d^3\rho_a}{dh^3}$$

and, if a Reynolds number rate constraint is in effect

$$\frac{dv}{dh}$$
, $\frac{d^3v}{\partial h^2}$ and $\frac{d^3v}{dh^3}$

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ANL62S
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                                                          SUBROUTINE ANL625(H,DIM,DOM,IDAM)
                                                 SUBROUTINE ANL62S(H,DIM,DOM,IDAM)

DIMENSION DIM(12)
DIMENSION DOM(5)
DATA A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15, A16, A17,
+A18, A19, A20, A21, A22, A23, A24, A25, A26, A27, A28, A29, A30, A31, A32,
-/ -.14553966-6, 6356.77, .256533416-10, 6356.77, .141168346-3,
-14.002385, -382829106-4, 216.23225, .150849788-3, 26.414270,
-684.10967, .67419880E-3, .044294588, .58500460, .85519675E-4,
-137, 47450, 10533.544, .49863416E-4, -013120767, 90188546,
-.253923546-3, -193.32352, 10180.367, .119218796-2, .034567717,
-3.3413764, -33886604E-4, -384.32662, 38131.516, .89812379E-4,
-028810210, -5.53623547

DATA B9, 88, B7, 86, B5, B4, B3, B2, B1, B0,
-/ .128406846 2, -.25070456 0, .22460528E- 2, -.11672987E- 4,
-38922542E- 7, -.86034597E-10, .12577373E-12, -.11709468E-15,
-22944405E-15, -.14878777E-22/

DATA CN/ -3483.67635/
DATA CN/ -3483.67635/
DATA C10, C9, C8, C7, C6, C5, C4, C3, C1, C0
-/ 283.7442331, -3,955242007, -5232974573, .05256403630,
-.1832962145E-2, .3432295909E-4, -.3930824139E-6, .2848535349E
-8, -.1269919974E-10, .3161762924E-13, -.3350145769E-16/
DATA B3, D2, D1, D0
-/ 253.316666, 6.8049727, -.56317016E-2, .12742813E-5 /
DATA C10, C9, C8, C7, C6, C5, C4, C3, C2, C1, C0
-/ .47255206E 2, -.96148320E 0, .87302363E- 2, -.46139476E- 4, .15580020E- 6, -.3477247E-9, .51217501E-12, -.47967392E-15, .25907821E-18, -.61476982E-22/
DATA CC8, CC7, CC6, CC5, CC4, CC3, CC2, CC1, CC0
-/ .10465949146..1576921089, -.733184858E-2.
 1.
23.
45.
67.
89.
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                                                       DATA CCC7, CCC6, CCC2, CCC4, CC3, CC2, CCC1, CCC0

1.71614797452E-4, -2.3584944834E-6, 1.9939747443E-8, -1.0159397972E-10, 2.8455868316E-13, -3.3504184588E-2, 1.7161479745E-8, -2.3584944834E-6, 1.9939747443E-8, -1.01593597972E-10, 2.8455868616E-13, -3.350418769E-16/

DATA CCC7, CCC6, CCC5, CCC4, CCC3, CCC2, CCC1, CCC0

/ 1.792472417E-5, 1.19638484658E-7, -7.1115518544E-10, 2.27646930528E-12, -3.0151311921E-15/

DATA CCCC6, CCCC5, CCCC4, CCC3, CCC2, CCC1, CCC0

/-4.399109148E-2, 2.0593775454E-3, -4.7169889668E-5, 5.98192423292E-7, -4.26693111264E-9, 1.593528513688E-11, -2.41210495368E-14/

DATA ROWNTO /3.5298375E11/

DATA DDIDOO

/ 1.12634032E-2, .38228439F-6/

DATA DDIDOO
/ 1.12634032E-2, .38228439F-6/
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                                                                           .76456878E-5/

BB7,BB6,BB5,BB4,BB3,BB2,BB1,BB0

.4921056E-2, .35018961E-4,1.55690168E-7,

-4.30172985E-10, .75464238E-12, -.81966276E-15,5.0355524E-19,

-1.33908993E-22/
                                                      DATA
                                                      DATA
                                                    ANL625
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                                                      POWER(Z) = A1/(Z + A2) + A3#ALOG(Z + A4) + A5#ALOG(Z + A6) +
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A7+ALDG(A8 - Z) + A9+ALDG(Z+(Z - A10) + A11) + A12+ATAN(A13+Z - A14) + A15+ALDG(Z+(Z - A16) + A17) + A18+ATAN(A19+Z - A20) + A21+ALDG(Z+(Z + A22) + A23) + A24+ATAN(A25+Z + A26) + A27+ALDG(Z+(Z + A28) + A29) + A30+ATAN(A31+Z + A32)
        76.
77.
78.
79.
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81. C
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                                                                                                                IF(IDAM.GT.O.O) 60 TO 1
IF(IDAM.LT.O.O) 60 TO 2
ASSIGN 50 TO IGD
60 TO 50
            83.
84.
85.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ANL625
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ANL625
                                                                                              1 ASSIGN 20 TO IAM
ASSIGN 10 TO IGO
GO TO 90
          86.
87.
88.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ANL625
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ANL625
                                                                                         2 ASSIGN 50 TO 1AM
ASSIGN 10 TO 160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ANL625
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            89.
            90.
90.

91.

92.

93.

94.

95. C

96. C

97. CT

100.

101.

102.

103.
                                                                                         40 X = M + X12

IF (X .GT. 550.) X=550.

IF (X .LT. 0. ) X= 0.

IF (X .GT. 195.) GO TO 1000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ANL625
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                                                                                                                  SET CONSTANTS
POWERX= POWER(X)
                                                        C
CTM
                                                                                                     TM = C10 + X=(C9 + X=(C8 + X=(C7 + X=(C6 + X=(C5 + X=(C4 + X=(C3 + X=(C2 + X=(C1 + X=(C1 + X=(C3 + X=(C2 + X=(
 104.
105.
106.
107.
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ANL625
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                                             C GRAVITY PARTIALS

R = 6356.765 + X

G = .396271577E6/R+2

G1 = -2.46/R

G2 = -3.461/R

C 6/TM PARTIALS

GTM = G/TM

GTM = GT
 108.
109.
110.
111.
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                                                 C PRESSURE
P = PO+ EXPO
P1 = PO+ EXPO
P2 = PO+ EXPZ
C DENSITY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ANL625
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                                                                                                                SITY
RHO = ROMATO+EXPO/TM
RHO1= (ROMATO+EXP1 - RHO+TM1)/TM
RHO2= (ROMATO+EXP2-2.+RHO1+TM1-RHO+TM2)/TM
 128.
129.
130.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ANL62S
ANL62S
ANL62S
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 131.
132.
133.
                                                                                                                60 TO 160
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                                                        C
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 134.
135.
136.
137.
                                                             1000 CONTINUE
                                                 THE CT. 195

THE D3 + X=(D2 + X=(D1 + X=D0))

THE D2 + X=(DD1 + X=DD0)

THE DD1 + X=DD0
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                                               C ROW .ST. 195
C P .GT. 195
RNO = E9 + X=(E8 + X=(E7 + X=(E6 + X=(E5 + X=(E4 + X=(E3 + X=(E2 + X=(E1 + X=E0)))))))
P = B9 + X=(B8 + X=(B7 + X=(B6 + X=(B5 + X=(B4 + X=(B3 + X=(B2 + X=(B1 + X=(B1 + X=(E5 + X=(E5 + X=(EE3 + X=(EE2 + X=(EE3 + X=(EE3 + X=(EE2 + X=(EE3 
                                                                                                                   RHO1 = E8 + X=(EE7 + X=(EE6 + X=(EE5 + X=(EE4 + X=(EE3 + X=(EE2 + ANL625
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149.
150.
151.
152.
153.
154.
155.
                                                                                                         X+(EE1 + X*EE0)))))))
P1 = B8 + X*(BB7 + X*(BB6 + X*(BB1 + X*BB0)))))))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ANL625
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                                                                                                                                                                                                                                                                                                                                      + X+(BB5 + X+(BB4 + X+(BB3 + X+(BB2 +
                                                                                                 RHO2 = EE7 + X*(EEE6 + X*(EEE5 + X*(EEE4 + X*(EEE3 + X*(EEE2 + X*(EEE1 + X*(EEE2 + X*(BBB + X*(BB + X*(BBB + X*(BB + X*(BB + X*(BBB + X*(BB + X*(BB
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                                                                                     5 NHO3 = EEE6 + X*(EEEE5 + X*(EEEE4 + X*(EEEE3 + X*(EEEE2 + X*(EEEE1 ANL625 + X* EEEE0))))

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      165.
166.
167.
168.
169.
                                                                       DYNAMIC VISCOSITY CALCULATIONS

7 TTF32 = (1.8+TM/TF)*SQRT(1.8+TM/TF)
TSC = 1.8+TM + SC
UMU = COEF1* TTF32/TSC
GO TO IAM
20 CONTINUE
TM = 1.8* TM
TM1 = X5 * TM1
TM2 = X9 * TM2
TM3 = X9/X4+TM3
TM20 = TM*2*
TM3 = X9/X4+TM3
TM20 = TM*2*
TM3 = TFSC/ TSC
GT1 = GT/ TSC
GT2 = 2.* GT/ TSC//TSC
GT3 = -2.* GT/ TSC//TSC
FT = TIF32
FT1 = 1.5* FT/ TM
FT2 = 40.75* FT/ TM20
FT3 = -0.375* FT/ TM30
UMU1 = UMUF*(FT*GT1*TM1 + GT*FT1*TM1)
UMU2 = UMUF*(FT*GT1*TM1 + GT*FT1*TM1)
UMU3 = UMUF*(FT*GT1*TM1 + GT*FT1)*TM3 *

(FT*GT2 + 2.*FT1*GT1 + GT*FT2)*TM1*TM1)
UMU3 = UMUF*(FT*GT1 + GT*FT1)*TM3 *

(FT*GT2 + 2.*FT1*GT1 + GT*FT2)* 3.*TM1*TM2 *

(FT*GT3 + 3.*FT1*GT2 + 3.*GT1*FT2 + GT*FT3)*T
TM = TM*1.8

SQRTTM = SQRT(TM)
CS = COM*SQRTTM
CS2 = MAFCOM*(TM*TM2 - .5*TM1**2)/(TM*SQRTTM)

500 DIM( 1) = 1.8*TM

DIM( 2) = 72*P
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                                                      CS2 = MAFCON*(TM*TM2 --

C 1500 DIM( 1) = 1.8*TM
DIM( 2) = X2*M
DIM( 3) = X3*RM0
DIM( 3) = X3*RM0
DIM( 5) = X5*TM1
DIM( 6) = X5*TM1
DIM( 6) = X6*P1
DIM( 7) = X7*RM01
DIM( 8) = CS1
DIM( 9) = X7*RM01
DIM( 8) = CS1
DIM( 10) = X7*RM01
DIM( 10) = X7*RM01
DIM( 11) = X11*RM02
DIM( 11) = X11*RM02
DIM( 12) = X11*RM02
DIM( 12) = X11*RM02
DIM( 12) = UMU
DIM( 3) = UMU
DIM( 3) = UMU
DIM( 3) = UMU
DIM( 3) = UMU
DIM( 5) = UMU
DIM( 5) = UMU
DIM( 5) = UMU
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Purpose

ANLo3P computes the atmospheric properties T_a , P_a , ρ_a and c_s for the '63 Patrick A.F.B. atmosphere. Moreover, when the Reynolds number rate constraint is in effect, it computes the atmospheric viscosity ν . In addition, the following derivatives

$$\frac{dT_a}{dh}$$
, $\frac{dP_a}{dh}$, $\frac{d\rho_a}{dh}$ and $\frac{dcs}{dh}$

and

$$\frac{d^2 T_a}{dh^2}$$
 , $\frac{d^2 P_a}{dh^2}$, $\frac{d^2 \rho_a}{dh^2}$ and $\frac{d^2 c_s}{dh^2}$

and, if any SVIC's are in effect

$$\frac{d^3\rho_a}{dh^3}$$

and, if a Reynolds number rate constraint is in effect

$$\frac{dv}{dh}$$
, $\frac{d^2v}{dh^2}$ and $\frac{d^3v}{dh^3}$

```
SUBROUTINE ANL63P(Q,PV,DOM,IDAM)

DIMENSION PV(12)

DIMENSION DOM(5)

DATA RO,RI,R2,R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13 /

8.3060902734182425, 3.6752156174349936

5.4871345414796215, 1.4678068127507852 ,

- 61463378717574668, -1.5399754331174728 ,

8.2668415705291311, 1.2852428316497672 ,

- 57234501173756826, -62238012815282961 ,

17229840038525958, 14809576798626313 ,

- 018335310293538199 , -01349827673004048 /

DATA SO,51,52,53,54,55,56,57,58,59,510,511,512,513 ,

8.497018499534999 , 4.168051278711044 ,

1.0011369797720595 , 3756892095830644 ,

-1.287997408735040 , 0.01497086070749703, 1674006844535595 , 1300346805855908 ,

-1.176664525367179 , -248063347106903 ,
 3.640551544325923 , 1062741660382213 ,

-0.0396181926386985 , -0.01364547919427445 /

DATA TO,TI,T2,T3,T4,T5,T6,T7,T8,T9,T10,T11,T12,T13 /

-1.0248437640715577 , -22838984971168512 ,

-0.0399380671279852 , 330884923044959274 ,

-55473185906456939 , -554828188087304384 ,

-869565556903838 , 676846024779332942 ,

-869766556903838 , -407686507177250266
                                                                                  SUBROUTINE ANLESP(Q,PV,DOM,IDAM)
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IF(IDAM.GT.0) 60 TO 1
IF(IDAM.LT.0) 60 TO 2
ASSIGN 50 TO IGO
GO TO 40
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      76.
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                              1 ASSIGN 20 TO IAM
ASSIGN 10 TO IGO
GO TO 40
      80.
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                                                                                                                                                                                                                           ANL63P
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                             2 ASSIGN 50 TO IAM
ASSIGN 10 TO IGO
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      84.
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                           40 H = Q
IF(H.LT.O.) H=0.
X= (H- 2.E5)*1.E-5
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                                              CALCULATE DENSITY, PRESSURE, AND SPEED OF SOUND
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                                              CALCULATE FIRST DERIVATIVES WO RADIUS
                                 DXRHO = UO +X*(U1 +X*(U2+X*(U3+X*(U4+X*(U5+X*(U6 +X*(U7 +X*(U8+

* X*(U9 +X*(U10 +X*(U11*X*U12)))))))))

DXP = VO + X*(V1 +X*(V2+X*(V3+X*(V4*X*(V6 +X*(V6 +X*(V7 +X*(V8+

* X*(V9 +X*(V10 +X*(V11*X*V12))))))))

DXA = WO + X*(W1 +X*(W11*X*V12)))))))))

PXA = WO + X*(W1 +X*(W11*X*W12))))))))))

PX(M9 +X*(W10 +X*(W11*X*W12))))))))))

PV(6) = -1.E-5*P*DXP

PV(7) = -1.E-5*RHO*DXRHO

PV(7) = 1.E-5*A*DXA
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                                             CALCULATE SECOND DERIVATIVES NO RADIUS
   116.
                                 OXRHO = X0 + X=(X1 + X=(X2 + X=(X3 + X=(X4 + X=(X5 + X=(X6 + X=(X7 ARL63P

+ X=(X8 + X=(X9 + X=(X10 + X=X11))))))))

OXP = Y0 + X=(Y1 + X=(Y2 + X=(Y3 + X=(Y5 + X=(Y6 + X=(Y7 ARL63P

+ X=(Y8 + X=(Y9 + X=(Y10 + X=Y11))))))))

OXA = I0 + X=(I1 + X=(I2 + X=(I3 + X=(I4 + X=(I5 + X=(I6 + X=(I7 ARL63P

+ X=(I8 + X=(I9 + X=(I10 + X=(I1))))))))

PY(10) = -1.E-10=PX=(QXP - DXPX=2)

PY(11) = -1.E-10=PX=(QXP - DXPX=2)

PY(12) = 1.E-10=A=(QXPX - DXPX=2)

GO TO IGO

COMITMUE
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                                             CALCULATE THIRD DERIVATIVES WO RADIUS
                                                                                                                                                                                                                         ANL 63P
                                 SXRHO = X1+ X*(B1 + X*(B2 + X*(B3 + X*(B4 + X*(B5 + X*(B6 + X*(B7 + X*(B8 + X*(B9 + X* B10))))))))

SXA = A0 + X*(A1 + X*(A2 + X*(A3 + X*(A4 + X*(A5 + X*(A6 + X*(A7 + X*(A8 + X*(A9 + X*(A10))))))))

DM(1) = -1.E-15* RHO*(SXRHO- (3.*0XRHO- DXRHO*DXRHO)*DXRHO)

ARRR = 1.E-15* A*(SXA + (3.*0XA + DXA*DXA)*DXA)
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                                             TEMPERATURE CALCULATIONS
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                                                    = A + A + CONST1
                                  TM
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                                             DYNAMIC VISCOSITY CALCULATIONS
                                 FT = (TM/TF)+ SQRT(TM/TF)
TSC = TM + SC
UMU = COEF1 + FT/TSC
DOM(2) = UMU
GO TO IAM
                                                                                                                                                                                                                        ANL63P
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| 150. | 20 CONTINUE | ANL63P | ANL63P
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SUBRØUT I NE APPLY



Purpose

APPLY computes the a vector defined by Equation 2.4-2 in Vol. I, together with the total first and second partials of a with respect to the state and the total first partials with respect to the costate, if needed.

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SUBROUTINE APPLY
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                                                                                         THIS ROUTINE CONTROLS THE CALCULATION OF THE APPLIED ACCELERATIONS ON THE VEHICLE. THEIR TOTAL FIRST AND SECOND PARTIALS WITH RESPECT TO THE STATE AND THEIR TOTAL FIRST PARTIALS WITH RESPECT TO THE COSTATE. NOTE THAT THE TIME RATE OF CHANGE OF THE MASS IS TREATED AS AN *APPLIED ACCELERATION*
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, XK1UV
, XK1GG
, XK1OG
, XK1ZG
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, XK3GG
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, XK2ZD
, XK2GV
, XK2GV
                                     +XKIMD
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*APZP

COMMON

*AMGR

*AVOR

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*AMPO
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*AMUZ AVMZ AGRZ
COMMON /AXLEY
*AVLY AGLY APPLP
*AMGLP AMGLY AVPLY
*AMRLY AVOLY AGOLY
*AVMLY AGMLY APMLG
*APVLG AMPLG APMLG
*AMOLG AVILG AGLG
*AVILG AGILG APZLG
*AGGLP AMGLP AGDLC
*AVALY AGGLP
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CAPPLY
APPLY
         161.
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APPLY
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APPLY
JUL21
APPLY
JUL21
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APPLY
APPLY
                                                                                       51 AV = -DRAGW/M

AVR = (-DBRCA - DRAGR)/M

AVR = (-DBRCA - DRAGR)/M

AVM = -AV/M

IF(J1 - 4) 511, 512, 512

511 ART = -(1: - ISPF*FVAC/ISP)/GEISP

ANY = 0.

AMR = AE*PAR*AMT

GO TO 513
 203.
204.
205.
206.
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APPLY
Jul21
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207.
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JUL21
APPLY
JUL21
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     513-
                                                                                         512 AMT = -SFC/CONST
AMV = -SFCV+T/CONST
AMR = -SFCR+T/CONST
 211.
212.
213.
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JUL21
JUL21
                                                                                       S13 AVT = CODME/M

AVD = TSDME/M

AVD = TSDME/M

AVA = (-TSDME/M

AXT = SIDME/M

AXD = "TCDME/M

IF(KODE ED. 4) GO TO 52

AXY = LIFTY/M

AXR = (-DBRSA + LIFTR)/M

AXR = (LIFTY - AXY/M

AGY = AXV*COSPHI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           JUL21
APPLY
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APPLY
APPLY
214.
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223.
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AGR = AXR*COSPMI
AGM = AXR*COSPMI
APV = AXX*SIMPHI
APR = AXR*SIMPHI
APA = AXR*SIMPMI
AXA = (TCDAE - DBCA + LIFTA)/M
AGT = AXX*COSPMI
AGD = AXD*COSPMI
AGT = AXX*COSPMI
APT = AXX*SIMPMI
APD = AXD*SIMPMI
APA = AXA*SIMPMI
ABA = AXA*SIMPMI
      224.
225.
226.
227.
228.
229.
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APPLY
APPLY
APPLY
APPLY
APPLY
APPLY
APPLY
      230.
231.
232.
233.
    234.
235.
236.
                                                                              52 IF(NODE .GT. 2) GO TO 102
COMPUTE THE STARRED FIRST PARTIALS OF THE A-VECTOR WITH RESPECT
TO THE STATE.
CALL MATMLT(AYIMP, AVT, DEPDEY, 4, 2, 8)
CALL MATMLT(AYIMP, AVV AYIMP, 4, 8)
COMPUTE THE TOTAL FIRST PARTIALS OF THE A-VECTOR WITH RESPECT TO THE COSTATE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  102
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    237.
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APPLY
APPLY
    241.
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243.
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APPLY
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APPLY
APPLY
APPLY
APPLY
APPLY
                                                                        101 IF(KONVER) RETURN
    244.
                                                                                                   IF(KONVER) RETURN

CALL MATMIT(AVLV AVT, DPDL 4, 3, 3)
ADD THE CONTRIBUTIONS DUE TO PHI TO THE ABOVE PARTIALS.
AGLG = AGLG - AP+PLE
AGLP - AP+PLP
APLG = APLG + AG+PLG
APLP = APLG + AG+PLG
APLP = APLF + AG+PLP
GO TO 103

COMPUTE THE STARRED FIRST PARTIALS OF THE A-VECTOR WITH RESPECT
TO THE STATE
   246.
247.
248.
249.
250.
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      253.
                                                                     102 CALL MATMIT(AYIMP, AVT, DPDY, 4, 3, 8)
IS PHI MONOPTIMAL
IF(KODE .GT. 3) GO TO 104
CALL MATADDE AVV, AVV, AYIMP, 4, 8)
GO TO 101
COMPUTE THE CONTRIBUTIONS DUE TO THE DECISION VECTOR TO THE TOTAL
FIRST PARTIALS OF THE A-VECTOR WITH RESPECT TO THE STATE.
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APPLY
APPLY
APPLY
   254.
255.
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   256.
257.
258.
259.
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APPLY
    260.
                                                                  103 CALL MATMLT(AYIMP, AYT, DPDY 4, 3, 8)
COMPUTE THE TOTAL FIRST PARTIALS OF THE A-VECTOR WITH RESPECT TO
THE STATE.
   261.
262.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 APPLY
                                                 C THE STATE.

104 CALL MATADD (AVV, AVV, AVIMP, 4, 8)
C ADD THE CONTRIBUTIONS DUE TO PHI TO THE ABOVE PARTIALS.

AGG = AGG - AP+PG
APG = AG+PG
APG = AG+PG
APG = AG+PG
APG = AFG + AG+PG
C IS THIS A CONVERGED TRAJECTORV.

IF (KONVER) RETURN
C CLEAR THE ARRAY OF SECOND PARTIALS MITH RESPECT TO THE STATE
DO 105 I = 81, 324

105 AXLE(I)= 0.
C COMPUTE THE EXPLICIT SECOND PARTIALS MITH RESPECT TO THE STATE.

IF(J1 - 4) 10501, 10502, 10502

10501 ARTT = (ISPFF*FVAC + 2.*ISPF*(1. - ISPF*FVAC/ISP))/GEISP/ISP
ARTW = 0.
ARTR = AE+PAR+ARTT
GO TO 10503
264.
265.
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APPLY
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JUL21
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APPLY
JUL21
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                                                    10502 AMTT = 0.
AMTV = -SFCV/COMST
AMTR = -SFCM/COMST
279.
280.
281.
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JUL21
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                                                     10503 AVVV = -DRAGVV/M
 282.
283.
284.
285.
                                                                                                  AVVV = -DRAGVV/M

AVRV = -DRAGV/M-AVRV = DRAGV/M-AVRV

AVVX = AVRV

AVRX = -(DBRR-COSA + DRAGRR)/M

AVRR = (DBRCA + DRAGR)/M-AVRV = AVRV

AVRV = AVRV/M-AVRV

AVRV = AVRV/M-AVRV = AVRV/M-AV
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APPLY
Jul21
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                                                    10504 AMYR = 0.
AMRV = 0.
AMVY = 0.
 292.
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APPLY
Jul21
    295.
296.
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GB TO 10506
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                                                                                                                                             10505 ANVV = -SFCVV+T/CONST
AMVR = -SFCVH+T/CONST
AMRV = AMVR
AMRR = -SFCHH+T/CONST
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JUL21
JUL21
JUL21
    297.
298.
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300.
                                                                                                                             MANY = -SFCYH-T/CONST

AMRY = ANYM
AMRY = ASFCHH-T/CONST

10506 IF(KODE .EQ. 4) GO TO 1051

AXYY = LIFTWYM
AXRY = LIFTWYM
AXRY = LIFTWYM
AGRY = AXYY-COSPHI
AGRY = AXYY-COSPHI
AGRY = AXYY-COSPHI
APWY = AXYY-SINPHI
APWY = AXYY-SINPHI
APWY = AXYY-SINPHI
APWY = AXYY-SINPHI
TEMP1= SINPHI-PG
AGRG = -AXY-TEMP1
AGRG = -AXY-TEMP1
AGRG = -AXY-TEMP1
TEMP2= COSPHI-PG
APWG = AXW-TEMP2
APRG = AXR-TEMP2
APRG = AXR-TEMP2
APRG = AXR-TEMP2
ARYY = (LIFTRR - BRR-SINA)/M
AGRY = AGRY
AGRR = AXRY-COSPHI
AGRR = AXRY-COSPHI
AGRR = AXRY-COSPHI
APWR = ARRY-SINPHI
APWR = AXRY-SINPHI
ARMY = (LIFTRR - 2.-AXM)/M
AGRM = AGRY
AGRM = ARMY-COSPHI
APWR = ARMY-SINPHI
C CORPUTE THE EXPLICIT SECOND PARTIALS WITH RESPECT TO THE STATE

1051 AVAY = -DRAGYA/M
AVAR = (DBRSA - DRAGRA)/M
AVAR = (DBRSA - DRAGRA)/M
AVAR = (DBRSA - DRAGRA)/M
AVAR = -DRAGYA/M

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APPLYY

APPLYY
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AND DECISION VECTORS

AVAW = -DRAGVA/M

AVAR = (DBRSA - DRAGRA)/M

AVIR = -AVI/M

AVAR = -AVI/M

AXRA = (LIFTRA - DBRCA)/M

AXRA = (LIFTRA - DBRCA)/M

AXRA = (LIFTRA - AXA)/M

AXRA = (LIFTRA - AXA)/M

AGAW = AXIAW-COSPHI

AGAW = AXIAW-COSPHI

AGAM = AXIAW-COSPHI

AGAM = AXIAW-COSPHI

AGAM = AXIAW-COSPHI

AFAW = AXIAW-SIMPHI

AYIA = AXIA
        335.
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AXTD =-AVT

AXTA = AVT

ASTD = AXTD+COSPHI

AGTA = AXTA+COSPHI

APTD = AXTD+SINPMI

APTA = AXTA+SINPMI

AXDD = AVD

AXDD = AVD

AXDD = AVD

AGDT = AGTD

AGDD = AXDD+COSPMI

AGDD = AXDD+COSPMI

AGDD = AXDD+SINPMI

APDT = APTD

APDD = AXDD+SINPMI

AXAA = (-TSDAE + DBSA + LIFTAA)/M

AGAT = AGTA

AGAD = AGDA

AGAA = AXAA+SINPMI

AYAA = AYAA+SINPMI

KSTAR = 2
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                                                                                PYRU = APDA

APAA = AXAA*SINPHI

1053 KSTAR = 2

IF(KODE .GT. 2) KSTAR = 3

II = -7

III = -2

DO 109 I = 1, 8

II = III + 8

II = III + 8

IJ = JJ = 3

106 CALL MATRIC(UM(1, J), AWY(1, JJ), DPDY(1, I), 4, 3, 1)

CALL MATRIC(UM(1, J), AWY(1, II), MM, 4, 8)

KK = -2

DO 107 K = 1, KSTAR

KK = KK + 3

107 CALL MATRIC(ZZ(1, K), AWW(1, KK), DPDY(1, I), 4, 3, 1)

CALL MATRIC(ZZ(1, K), AWW(1, KK), DPDY(1, I), 4, 3, 1)

CALL MATRIC(UM, ZZ, DEPDEY, 4, 2, 8)

CALL MATRIC(UM, AVT, PRODICI, II), 4, 8)

CALL MATRIC(UW, AVT, PRODICI, II), 4, 2, 8)

GO TO 109
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        389.
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                                                                                          GO TO 109

108 CALL MATMLT(WW, ZZ, DPDY, 4, 3, 8)
CALL MATADDCAYY(), II), AYY(1, II), WW, 4, 8)
CALL MATADDCAYY(), II), AYY(1, II), WW, 4, 8)
109 CALL MATADDCAYY(), II), AYY(1, II), WW, 4, 8)
IF(KODE, 6T. 3) RETURN
AGT6 = -AXT*TEMP1
AGD6 = -AXT*TEMP1
AGA6 = -AXD*TEMP1
APT6 = AXT*TEMP2
APT6 = AXT*TEMP2
APA6 = AXA*TEMP2
IF(KODE, EQ. 3) 60 TO 1091
CALL MATMLT(WW, AWG, DEPDEY, 4, 2, 8)
GO TO 1092
      411.
412.
413.
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APPLY
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                                                                                1091 CALL MATMLT(HM, AMG, DPDY, 4, 3, 8)
      425.
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                                                                              1092 CALL MATADD(AVV(1, 9), AVV(1, 9), WW, 4, 8)

C CLEAR THE ARRAY OF SECOND PARTIALS WITH RESPECT TO THE STATE AND

C COSTATE.

DO 110 I = 337, 432

110 AXLE (1)= 0.

IF(XODE .EQ. 2) GO TO 1101

C COMPUTE THE EXPLICIT SECOND PARTIALS WITH RESPECT TO THE STATE AND

C COSTATE.
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                                                                                                                                    COMPUTE THE EXPLICITIONS TO THE EXPLICATION OF THE PLANT OF THE PLANT
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APVLG = AXV=TEMP2
APRLG = AXM=TEMP2
APRLG = AXM=TEMP2
AGVLP = AXV=TEMP3
AGRLP = AXX=TEMP3
AGRLP = AXX=TEMP4
APRLP = AXX=TEMP4
AFRLP = AXX=TEMP4
AFRLF = AXX=TEMP4
AFRLG = AXX=TEMP1
AGALG = AXX=TEMP1
AFRLG = AXX=TEMP2
AFRLG = AXX=TEMP3
AGALF = AXX=TEMP3
AGALF = AXX=TEMP3
AGALP = AXX=TEMP4
AFRLP = AXX=TEMP4
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                                                                                  113 CALL MATMLT(NW, AWLY(1, III), DPDY, 4, 3, 8)

114 CALL MATADD(AYLY(1, II), AYLY(1, II), NW, 4, 8)

RETURN
END
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                     482.
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APPLY
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ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOCK	ORAG K	E LOC	SUBRO	CODI	E USAGE E VAR
AE	Aezit	1	Total mezzle exit area (FT ²)	/DYNA	/(89)	APPLY ARCIN IMPUL! NLDRY TH2	1 0 1 1	AE AE AE AE
APLP	∂a ^v /∂λ _v	Ħ	The first entry in a 4x3 matrix that contains $\partial a/\partial \lambda_{\mu}$, $\partial a/\partial \lambda_{\gamma}$ and $\partial a/\partial \lambda_{\mu}$	/AXLE	/(335)	APPLY NLDRV	M	APLP APLP
AV	* A		The first word of a four word array that contains the vector of applied accelerations defined by Equation 2.4-2 in Vol.I of this document.	/AXLE	/(1)	APPLY APPLY NLDRY	1 0 M	AV AXLE AV
AVV	∂a ^v /∂v	n	The first entry in a 4x8 matrix that contains the total partial derivatives of the a vector with respect to the QL state vector (excluding the heating state), aa/ay.	/AXLE	/(-	5)	APPLY	M 1 -	AVV
AVVR	9(884\8A)\9H		The first entry in a 4x8 matrix that contains a(5a/6y)/ah	/AXLE	/(165)	APPLY NLDRV	0	AVVR AVVR
AVV	9(8ª*/8V)/9V	, 0	The first entry in a 4x8 matrix that contains a(8a/8y)/av.	/AXLE	/(69)	APPLY APPLY NLDRY	0 1 1	844A 844A
AW		D	A 4x3 array containing A _p	/APPLY	/(+)	APPLY	D	AW
AMG			A 4x3 array containing Apply	/APPLY	/(*)	APPLY	C	AM6
AWLY			A 4x9 array containing ∂(A _m)/∂λ _γ , ∂(A _m)/∂λ _γ and ∂(A _m)/∂λ _φ .	/APPLY	/{*)	APPLY	C	AMLY
AWW	- ,		A 4x9 array containing App	/APP̃LŸ	/(*)	APPLY	C	A WW
AWY			A 4x24 array containing Apy	/APPLY	/(+)	APPLY	C	AWY
AXLE	av	0	The first word of a four word array that contains the vector of applied accelerations defined by Equation 2.4-2 in Vol.I of this document.	/AXLE	/(1)	APPLY APPLY NLDRY	M 0 1	AV AXLE AV
AYY	9(8a*/8V)/3V		The first entry in a 4x8 matrix that contains $\partial (\delta a/\delta y)/\partial V$.	/AXLE	/(69)	APPLY APPLY NLDRY	0 1 1	AVVV AVV
CODAE	cos(α-6 _E)	1	See symbol	/DYNA	/(151)	AL1 AL4 AL6 AL7 AL8 AL9 APPLY CONTRI NLDRY TH3 UT	1 1 1 1 1 1 1 1	CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE
COSA .	c a s a	1	See symbol	/DYNA	/(10)	AL1 AL4 AL6 AL7 AL8 AL9 APPLY CONTRI NLDRY OUTPU1 TH3 UT	I I I I I I	COSA COSA COSA COSA COSA COSA COSA COSA
COSPHI	cos∳	I	See symbol .	/DYNA	/(93)	AL1 AL4 APPLY ARCIN CONTRL OUTPUT		COSPHI COSPHI COSPHI COSPHI COSPHI



FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	ST BLOC	ORAG	LOC	SUBROUT Subr C	INE USAGE
DB	D _b	I Base dreg	. (LBS)	/DYNA	/(163)	AL4 AL6 AL7 AL8 AL9 APPLY CONTRL NLDRY OUTPUT STATEF	I DB I DB I DB I DB
DBR	aD _b ∕aR	1 See symbol	:	/DYNA	/(86)	AL1 AL4 AL6 AL7 ALB ALP APPLY STATEF TH3 UT	CBR DBR DBR DBR DBR DBR DBR
DBRR	∂ ² D _b /∂R ²	i See symbol	· • • • • • •	/DYNA	*	87)	AL6 1 AL7 1 AL8 1 AL9 1 APPLY 1	DBRR DBRR DBRR DBRR DBRR
•		•					STATEF I	DBRA DBAR
DEPDEY	δр/бу	I A 2±8 matrix δρ/δy =	that contains $\partial p/\partial y _{\mathbf{u}} = constant$	/MATS	/(285)	ALGCON A	
DPDL	9m/9y	Ι Α 3x3 matrix ∂#/∂λ	that contains $\partial u/\partial \lambda_{v}$, $\partial u/\partial \lambda_{y}$ and	/MATS	/(301)	ALGCON I	
DPDY	∂#/∂y	I A 3x8 matrix	that contains the total first partial of the in-plane-control vector art the	/MATS	/(261)	ALGCON I	DP DY DP DY
DRAG	D	I Aerodynamic	drag (LBS)	/DYNA		69)	ALS I AL7 I AL8 I AL9 I AL9 I AL9 I CONTRL I ENVPRQ I NLDRY I OUTPUT I TH3 I UT P	DRAG DRAG DRAG DRAG DRAG DRAG DRAG DRAG
DRAGA	∂D/∂ α	I See symbol		/DYNA	/(72)		DRAGA DRAGA DRAGA DRAGA DRAGA DRAGA DRAGA
DRAGAA	∂ ² D/∂ α ²	I See symbol		/DYMA	/(78)		DRAGAA DRAGAA DRAGAA DRAGAA DRAGAA DRAGAA DRAGAA



ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOCK	LOC	SUBROL Subr	CODE V	AGI
DRAGR	ad/ar	i See symbol		/DYNA	/(-71)	ALS AL7 AL8 AL9 APPLY TH3 UT	I DRA	GR GR GR GR
DRAGRA ,	∂ ² D/∂R∂α	I See symbol	·	/DYNA	/(11)	AL1 AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRA	GR GR GR GR
DRAGRA .	∂ ² D/∂R²	I See symbol		/DYNA	/(76)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAI I DRAI I DRAI I DRAI I DRAI I DRAI	GRE GRE GRE GRE
DRAGV	ab/av 	i See symbol		/DYNA	/(70) -	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAI I DRAI I DRAI I DRAI I DRAI I DRAI	6 A 6 A 6 A 6 A
DR A G V A	∂ ² D/∂V∂∝	I See symbol		/DYNA	/(75)		I DRAGI DRAGI DRAGI DRAGI DRAGI DRAGI M DRAGIM	6 VA 6 VA 6 VA 6 VA 6 VA
DRAGUR	a ² D/avaR	1 See symbol	·	/BYNA	/(74)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAI I DRAI I DRAI I DRAI I DRAI I DRAI	GVR GVR GVR
DRAGVV	a²¤/a∀²	I See symbol		/BYNA	/(73)	AL5 AL7 AL8 AL9 APPLY TH3 UT	I DRAI I DRAI I DRAI I DRAI I DRAI I DRAI	244 244 244 244 244
EAVV	δ a ^v / δ v	a is optimal, Sa/Sy = When w is new	ry in a 4x8 matrix that contains, when delay a constant optimal,	/AXLE	/(37)	APPLY NLDRY	I EAV	
FVAC		δa/δy = 1 Total vacuum	thrust (recket) (LBS)	/DYNA	/(33)	APPLY ARCIN IMPULS NLBRY STATEF TH2	I FVAC M FVAC M FVAC I FVAC I FVAC	C C C

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		STOR. BLOCK	LOC	SUBROUTIA SUBR COD	E USAGE
GR	9,	ı	Gravitational acceleration at surface of t	he earth. (FT/SEC ²)	/GLOBAL/	1)	ALS I APPLY I BRANPT I COSTAB I COSTAI I INTRPT 1 OUTPUT I PDBCGL I GLTOSZ I SALVE I STATEF I TH3 I	GR GR GR GR GR GR GR GR GR
15P	i sp	1	Vacuum specific impulse	(SECS)	/DYNA /	45)	APPLY I ARCIN O IMPULS O	15P 15P 15P
ISPF	al _{sp} /at	I	See symbol		/DYNA /	179)	APPLY I Impuls 0	ISPF ISPF
ISPFF	∂ ² I _{SP} /∂T ²	1	See symbol		/DYNA /	180)	APPLY I	ISPFF ISPFF
11		1	Thrust option flag. J1 = 1: Constant thrust; J1 = 2: Input vacuum thrust; J1 = 3: Powered total acceleration lis J1 = 4: Air-breather engine.	ılt;	/DYNA /	173)	APPLY I ARCIN O CONTRL M FORCES I NPLANE I STATEF I THROTL M	J1 J1 J1 J1 J1
KODE	• •	I	Steering vector flag KODE = 0: Free fail, $\alpha = \phi = 0$; KODE = 1: Both α and ϕ optimal; KODE = 2: α optimal and $\phi = 0$; KODE = 3: α nonoptimal and ϕ optimal; KODE = 4: Vertical rise or pitchover; KODE = 5: α nonoptimal and $\phi = 0$.		'/ 5 YNA '/(- 25)	APPLY I ARCIN O CONTRL M FORCES I NLDRY I STATEF I	KODE KODE KODE KODE
KONVER	,	1	Logical flag that indicates to the QL modul the QL iteration is converged.	e that	/CNTRL /(28)	ALGCOM I APPLY I ARCIM I COHOMO O GROPE O NLORY I OUTPUT I RKUTT1 I	KONVER KONVER KONVER KONVER KONVER KONVER KONVER
LIFT	L	1	Aerodynamic lift	(L85)	/DYNA /C	60)	AL4 I AL5 I AL6 I APPLY I CONTRL I ENVPRQ I OUTPUT I TH3 I UT 0	LIFT LIFT LIFT LIFT LIFT LIFT LIFT LIFT
LIFTA	∂L/∂œ	1	See symbol .		/DYNA /C	63)	AL1 I AL4 I AL5 I AL6 I APPLY I TH3 I UT O	LIFTA LIFTA LIFTA LIFTA LIFTA LIFTA
LIFTAA	∂ ² L/∂ α ²	T	See symbol		/DYNA /(144)	AL1 I AL4 I AL5 I AL6 I APPLY I TH3 I UT O	LIFTAA LIFTAA LIFTAA LIFTAA LIFTAA LIFTAA

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORAGE Block Lo	SUBPOUTINE USAGE OC SUBP CODE VAR
LIFTM	∂ L/∂∎	I See symbol	•	/DYNA /(81) AL4 LIFTM AL5 LIFTM AL6 LIFTM APPLY LIFTM TH3 LIFTM UT 0 LIFTM
LIFTMA	∂ ² L/∂m∂α [·]	I See symbol		/DYNA /(85) AL1 I LIFTMA AL4 I LIFTMA AL5 I LIFTMA AL6 I LIFTMA APPLY I LIFTMA TH3 I LIFTMA UT O LIFTMA
LIFTMM	∂ ² L/∂ m ²	i See symbol		/DYNA /(84) AL4
LIFTR	∂L/∂R	I See symbol		/DYNA /C	62) AL4 I LIFTR AL5 I LIFTR AL6 I LIFTR APPLY I LIFTR TH3 I LIFTR UT O LIFTR
LIFTRA .	∂ ² L/∂R∂ α	I See symbol		/DYNA /(58) ALI I LIFTRA - AL4 I LIFTRA AL5 I LIFTRA AL6 I LIFTRA APPLY I LIFTRA TH3 I LIFTRA UT O LIFTRA
LIFTRM	∂ ² L/∂R∂∎	I See symbol		/DYNA /(8	33) AL4 I LIFTRM AL5 I LIFTRM AL6 I LIFTRM APPLY I LIFTRM TM3 I LIFTRM UT O LIFTRM
LIFTRR	∂ ² L/∂R ²	I See symbol		/DYNA /((37) AL4 I LIFTRR AL5 I LIFTRR AL6 I LIFTRR APPLY I LIFTRR TM3 I LIFTRR UT O LIFTRR
LIFTV	9L/9V	I See symbol		/DYNA /((01) AL4 I LIFTY AL5 I LIFTY AL6 I LIFTY APPLY I LIFTY TH3 I LIFTY UT O LIFTY
LIFTVA	∂ ² L/∂V∂∝	1 See symbol		/DYNA /(6	ALI I LIFTVA AL4 I LIFTVA AL5 I LIFTVA AL6 I LIFTVA APPLY I LIFTVA TH3 I LIFTVA UT O LIFTVA
LIFTUR	a ² L/aVa∎	I See symbol	•	/DYNA /(E	12) AL4 I LIFTYM AL5 I LIFTYM AL6 I LIFTYM APPLY I LIFTYM TM3 I LIFTYM UT O LIFTYM

FORTRAN Symbol	MATH Symbol	COC	E DESCRIPTION		STORAGE BLOCK LOC			SUBRO!	SUBROUTINE USAGE SUBR CODE VAR		
LIFTVR	¹ a²∟/avaR	1	See symbol		/DYNA	/(65)	AL4 AL5 AL6 APPLY TH3	1 1 1 1	LIFTYR LIFTYR LIFTYR LIFTYR LIFTYR	
LIFTVV	9 <mark>2</mark> L/ 9V ²	. I	See symbol		/DYNA	/(64)	AL4 AL5 AL6 APPLY TH3 UT	1 1 1 0	LIFTYA LIFTYA LIFTYA LIFTYA LIFTYA LIFTYA	
n	•	I ·	Ross	(G'S)	/B	/(97)	AL4 AL7 AL8 AL9 APPLY BRANPT COSTAB COSTAB INTRPT NLDRY OUTPUT SALVEF UR APUP	1 1 1 1 1 1	***************************************	
PAR .	aP _a /aR _	~1	See symbol		/DYNA	11	18)	APPLY TH2	I	PAR PAR	
PARR	∂ ² P _• /∂R ²	1	See symbol		/DYMA	/(22)	APPLY TH2	I I	PARR PARR	
P6	٠,	1,	See symbol		/MATS	/(551)	AL4 APPLY ARCIN CONTRL	R 1 0	P G P G P G	
PLG	*\hat{\chi}	1	See symbol .		/MATS	/(570)	APPLY ARCIN CONTRL	1 0 0	PLG PLG PLG	
PLP	***	· I	See symbol		/MATS	/(571)	APPLY ARCIN CONTRL	1 0 0	PLP PLP PLP	
PROD1	∂(δρ/δ y)/∂y	1	A 2x64 metrix that contains the total first pertials of the metrix DEPDEY art the QL state		/MATS	/(310)	ALGCON ALGCON APPLY APPLY		PROD1 PROD5 PROD1 PROD5	
PR005	∂(δρ/δy)/∂y	I	A 2x64 matrix that contains the total first pertials of the metrix DEPDEY art the OL state		/MATS	/(310)	ALGCON ALGCON APPLY APPLY	1	PROD1 PROD5 PROD1 PROD5	
PRDD9		3	A 2x64 matrix that contains $\partial(\delta p/\delta y)/\partial\lambda_y$, $\partial(\delta p/\delta y)/\partial\lambda_y$ and $\partial(\delta p/\delta y)/\partial\lambda_{\psi}$.		/MATS	/(502)	ALGCON APPLY]]	PROD9	
SFC		1			/ DYNA	/(225)	APPLY	1	SFC	
SFCH		1	Partial of SFC art h		/DYNA	/(227)	APPLY	1	SFCH	
SFCHH		1	Second partial of SFC wrt h		/DYNA	/(229)	APPLY	1	SFCHN	
SFCV		I	Partial of SFC mrt V		/DYNA	/(APPLY	I	SFCV	
SECVH			Second partial of SEC art V and b		/DVMA	11	2201	ADDIV	•	CECHM	

/DYNA /(230) APPLY 1 SECVH

/BYNA /(228) APPLY 1 SFCVV

I Second partial of SFC art V and h
I Second partial of SFC art V

SFCV SFCVH

SFCVV

FORTRAN SYMBOL	MATH Symbol	CODE	DESCRIPTION	S1 BLOC	OPAGE K LOC	SUBROUTINE USAGE SUBR CODE VAR
SIDAE	sin(α-6 _E)	I See symbol		/DYNA	/(152)	AL1 SIDAE AL4 SIDAE AL6 SIDAE AL7 SIDAE AL8 SIDAE AL9 SIDAE APPLY SIDAE CONTRL SIDAE TH3 SIDAE UT O SIDAE
SINA -	sinα	l See symbol	-	/DYMA	/(9)	AL1 I SINA AL4 I SINA AL6 I SINA AL7 I SINA AL7 I SINA AL9 I SINA APPLY I SINA CONTRL I SINA CUTPUT I SINA TM3 I SINA UT M SINA
SINPHI	sin≠	I See symbol		/DYNA	/(92)	AL1 I SIMPHI AL4 I SIMPHI APPLY I SIMPHI CONTRL M SIMPHI OUTPUT I SIMPHI
٠	. T .	I Threst		(LBS) ZDYMA	((42)	ALGCON M T AL1 I T AL4 I T AL6 I T AL7 I T AL8 I T AL9 I T AL9 I T APPLY I T APPLY I T CONTRL M T DL2 I T IMPULS I T OUTPUT I T TH1 I T TH2 I T TH3 I T TH4 I T

SUBRØUT I NE ARCEN



Purpose

ARCEN handles the interfacing of dynamic quantities between the present subarc and the subsequent subarc.

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SUBROUTINE ARCEN
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                                                                                      THIS ROUTINE MANDLES INTERFACING OF DYNAMIC QUANTITIES BETWEEN PRESENT AND SUBSEQUENT ARCS.

LOGICAL SMITCH, ILOAD
REAL MACH, ISP, ISPR, ISPR, ISPT, ISPV, ISPVR, ISPVR, ISPVR, ISPRR, LIFTVA, ISPRR, SRR, KODE, MACH, MACHR, SRR, KODE, MACH, MACHR, SRR, KODE, MACH, MACHR, ISPRP, ISPR, ISPRR, ISPRR, SPRR, ISPRR, 
                                                                                                                                                                                                                                          THIS ROUTINE HANDLES INTERFACING OF DYNAMIC QUANTITIES BETWEEN PRESENT AND SUBSEQUENT ARCS.
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                                                                                                  EQUIVALENCE (NOM, V)

COMPUTE TRAJECTORY TIME AT WHICH NEXT ARC BEGINS RETURN
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FORTRAN SYMBOL	MATH Symbol	CODE	DESCRIPTION		BLOC	K	E LOC	SUBROU SUBR		E USAGE E VAR
TAU	*	î Subaro	: duration :	(SEC)	/D	//	98)	ARCEN INARC NLDRV OUTPUT STATEF		TAU TAU TAU TAU TAU
TSTART		M Traje	tory time at which present subar	c commenced.	/DYNA	/(141)	ARCEN ARCIN STATEF	M M	TSTART TSTART TSTART

SUBRØUT I NE ARCIN

Purpose

ARCIN handles the initialization of arc-dependent flags and parameters.

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SUBROUTINE ARCIN
THIS ROUTINE HANDLES THE INITIALIZATION OF ARC-DE-
PENDENT FLAGS AND PARAMETERS.
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                                                                                THIS ROUTINE HANDLES THE INITIALIZATION OF ARC-DE-
PENDENT FLAGS AND PARAMETERS.

DIMENSION XX(1)

REAL MAGBY, MU, M, LV, LGAM, LPSI, LR, LRHO, LMU, LR, LTAU, NOM

LHT
COMMON /D/

** A, M, X1(4)

** ALT, HHO, MU, M, TAU, HT, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU,

** ALT, HHO, MU, M, TAU, HT, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU,

** LHT, DIÓP, DÍLO, ÉV(40), ZSAVE(20), QT(20), MPOÍNT(20), DELT(20)

DIMENSION NOM(20)

EQUIVALENCE (MOM, V)

COMMON /CNTRL/

** NU JIER ITAPA ITAPB JMIN JMAX LINES KPT MOM

** KARD JNOX(4)

** PAGE MMP NUP IARC TASTA IARX XIJAE KONVER NOPRNT,

** INBORY, NUPAGE IVARY(20), NN NOVARY PLAST ZLAST, KODES

LOGICAL INBORY, NELMOMP, KONWER, NOPPHNT, NUPAGE

LOGICAL SHITCM, ILCADA,

LOGICAL SHITCM, ILCADA,

** LIFTY LIFTY LIFTY LIFTY LIFTY LIFTY LIFTY

** LIFTA LIFTY LIFTY LIFTY LIFTY LIFTY ALIFTAN,

** LIFTA LIFTY LIFTY LIFTY LIFTY ALIFTY AND ACHY

** REAL HIFTY LIFTY LIFTY LIFTY LIFTY AND ACHY

** REAL LIFTY LIFTY LIFTY LIFTY LIFTY AND ACHY

** REAL LIFTY LIFTY LIFTY LIFTY LIFTY AND ACHY

** REAL MAGNY, MACHER MACHUR, MACHUR

REAL LIFTY LIFTY LIFTY LIFTY LIFTY AND ACHY

** PAGE AND LOGGAT TAMP PA ROUR CSS TEMPR PAR

** ROOR CSS TEMPR PARR NORR CSSR KODE MACH OF ACHY

** SID DYNOIL OMEGAT TAMP PA ROUR CSSR KODE MACH OF ACHY

** SID DYNOIL OMEGAT TAMP PA ROUR CSSR KODE MACH OF ACHY

** SID DYNOIL OMEGAT TAMP PA ROUR CSSR KODE MACH OF ACHY

** SID DYNOIL OMEGAT TAMP PA ROUR CSSR KODE MACH OF ACHY

** SID JUPATI LIFTY LIFTR LIFTY LIFTY
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                                                                                                                                                                                                                                                                                                                                                                                                    , XK3A
, XK2TT
, XK2DD
, XM42
, XK3G
, XK3O
, XK3O
```

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77.
78.
79.
80.
81.
82.
83.
84.
  86.
87.
90.
91.
93.
95.
97.
97.
97.
97.
                                                                                                                                                  GLOBAL
GLOBAL
GLOBAL
GLOBAL
ARCIM
ARCIM
ARCIM
ARCIM
 104.
105.
106.
 109.
110.
111.
                      MTTS = MTT
SAV2 = ALPHA
SAV3 = TSTART
SAV4 = DELTAE
SAV5 = TSTAGE
 112.
113.
114.
115. C
116.
117.
118.
                                                CLEAR THOSE QUANTITIES THAT SHOULD BE.
                       PG = 0.
                      PLG = 0.
PLP = 0.
DO 101 I = 13, 218
               101 XX(1) = 0.
                                                                                                                                                   ARCIM
                                                RESTORE QUANTITIES SAVED ABOVE
                                                                                                                                                  ARCIN
JUL21
ARCIN
         C
                      IDAM ==1
MTT = MTTS
ALPHA = SAVZ
TSTART = SAV3
DELTAE = SAV4
TSTAGE = SAV5
                    IARC

CHECK FOR AIRBREATHER

IF(JPRO .NE. 2) GO TO 1011

CALL INBYPD(AHDB)

J1 = 4

IPOW = 1

IF(ADB .GT. 0) IPOW = 2

GO TO 109
                                                                                                                                                  ARCIM
                                               STORE THE ARC NO. IN FLOATING PT.
         C
                                                                                                                                                  ARCIM
 129
130. C
                                                                                                                                                  ARCIM
JULZI
JULZI
                                                                                                                                                                 1011-
                                                                                                                                                  10F51
10F51
10F51
10F51
 134.
                                                                                                                                                   JULZI
                                                                                                                                                  JUL21
ARCIM
                                                WAS A NEW THRUST TABLE NO. IMPUT FOR THIS ARC.
 138.
           1011 IF(MT .LT. 0) 60 TO 102
C YES. REINITIALIZE INTERNAL THRUST TABLE NO. AND IGNITION TIME.
                                                                                                                                                  JUL21
ARCIN
ARCIN
ARCIN
                                                                                                                                                                 102-
 139
                      TSTAGE = TSTART

IS THERE A POSITIVE THRUST TABLE NO.
              102 IF(MTT .LE. 0) 60 TO 107

VES. CHECK THE INITIAL VALUE IN THE TABLE.

CALL SPLINE(MTT, 0., FVAC, FVACT, FVACTT)

IF(FVAC) 103, 104, 105

LESS THAN ZERO. PRINT MARMING
145.
146.
147.
148.
                                                                                                                                                  ARCIN
ARCIN
ARCIN
ARCIN
         С
```

106	10	17-	
106		AT-	
106		17-	
106		17-	
106		.,,	- 10
106			10
106			
108-7			
108-7			
108-7			
108-7			
108-7			- 10
	05		10
	05		. 10
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	05		- 10
	05		10
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1127			
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1 1 1 1	1103—	1103	1103

219. 220.	SAMMAD = GMDOT/RAD RETURN	ARCIN ARCIN	1
	COSPNI = 1. IF(IMODE .EQ. 2) GO TO 113 OPTIMAL BANK ANGLE. INITIALIZE COSINE OF BANK ANGLE CGLG = LGAM+COS(GAM) COSPNI = CGLG/SpR7(LPSI++2 + CGLG++2)	ARCIN ARCIN	113
	IF(IARC .EQ. 1) RETURN SET UP FOR STATE INEQUALITY CONSTRAINT. INQF = INEQFL(IARC - 1) IF(INDF .EQ. 0 .OR. KONVER) RETURN IF(INDF .EQ. 9) IDAM = 1 RETURN END	ARCIN ARCIN ARCIN ARCIN ARCIN ARCIN ARCIN	
·			

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		STOR4 BLOCK	LOC	SUBROUTI SUBR CO	NE USAGE DE VAR
AE	Aexit	. 0	Total nozzie exit erea	(FT ²)	/DYNA /(89)	APPLY I ARCIN O IMPULS I NLDRY I TH2 I	AE AE AE AE AE
ALFMAX	^Q MAX	1	Maximum angle of attack	(DEG)	/ARCDAT/(16)	ARCIN I NPLANE 1	ALFMAX ALFMAX
ALMAX	Q	0	Magnitude of angle of attack constarint	(RADS)	/DYNA /(162)	ARCIN O	ALMAX ALMAX
ALPHA .	Œ		Angle of attack	(RAD)	/DYNA /(79)	AERDCO 1 ALGCOM M ALZ 1 ARCIN M CONTRL M ENVPRO 1 MONECO 1 NOLOMECO 1 TRAJIM O UTPUT 1 TRAJIM O UTRAPUP 1	ALPHA ALPHA ALPHA ALPHA
COSPHI	cos#		See symbol	-	/DYNA /(93)	AL1 I AL4 I APPLY I ARCIN O CONTRL M OUTPUT I	COSPHI COSPHI COSPHI COSPHI COSPHI COSPHI
DELTAE	ę E	Ħ	Engine deflection	(RADS)	/DYNA /(155)	ALGCON MARCIN MOLI I I OUTPUT I TRAJIN OUT I	DELTAE DELTAE DELTAE DELTAE DELTAE DELTAE
£J	Awxit	I	Nozzie exit area	(FT ²)	/ARCDAT/(2)	ARCIN I	£J
FRATE		A	Input rated vacuum thrust per engine	(LBS)	/ARCBAT/(42)	ARCIM M	FRATE
FRATED		0	18 of the maximum rocket vacuum thrust	(L85)	/DYNA /C	171)	ARCIN O	FRATED
FVAC		n	Total vacuum thrust (rocket)	(LBS)	/DYNA /C	33)	APPLY I ARCIN M IMPULS M NLDRY I STATEF M TH2	FVAC FVAC FVAC FVAC FVAC FVAC
FVACT	-	I	Not used.		/DYMA /C	371	ARCIM I STATEF M TH2 I	FVACT FVACT FVACT
FVACTT		1	Not used.		/DYNA /(41)	ARCIM I STATEF M TH2 I	FVACTT FVACTT FVACTT
GAM	7	I	Relative flight path angle.	(RAD)	/0 /0	92)	ARCIM I ENVPRO I OUTPUT I STATEF I WRAPUP I	gam gam gam gam gam
GAMMAD		0	Pitch rate	(RAD/SEC)	/DYNA /C	88)	AL4 I ARCIN D CONTRL I NLDRV 1	GAMMAD GAMMAD GAMMAD GAMMAD
GROOT	7*	τ	Pitch rate	(DEG/SEC)	/ARCDAT/(151	ARCIM I	GADOT

FORTRAN	MATH	CODE DESCRIPTION		STORA		SUBFCUTIA	<u> </u>
SYMBOL	SYMBOL	DESCRIPTION		BLOCK	FOC.	5088 CD1	1E < 2 //
LARC	· 1	l Suberc number.		/CHTRL /(24)	ARCIN I BCOND A BNDRY A BRAHPT I	IARC IARC IARC IARC IARC
,						COSTAB I COSTAI I ENOPT I FORCES I INARC M INTRPT I MAGIC R	IARC IARC IARC IARC IARC IARC IARC
٠.						MARCH 1 QLTOSZ 1 SALVE M WRAPUP M	CRAI CRAI CRAI CRAI
RTAI		I Atmosphere option flag		/ARCDAT/(73	ARCIE I MLORY I OUTFUT I STATEF I	IATA IATA IATA
IDAM .		O Optional atmospheric calculations flag. IDAM = -1: Compute ∂ ³ ρ _α /∂R ³ ; IDAM = 0: No optional calculations; IDAM = 1: Compute ∂ ³ ρ _α /∂R ³ , μ _α , ∂μ _α /∂R,	etc.	/DYNA /(218)	ARCIN DERROR I MPLAKE D STATEF ! WRAPUP D	PAGI PAGI PAGI PAGI
TLOAD		A Lagical flag that is true if there is any peregrapaic load on the vehicle.		/DYNA /(181)	ARCIN A CONTRL I MPLANE I UT I	1LOAD 1LOAD 1LOAD 1LOAD
IRODE		S Control mode option flag		/ARCDAT/(9)	ARCIN I CONTAL I NPLANE I	irode Irode Irode
IKEOFL		§ A 20 word array that contains the code number the state variables inequality constraint th applies on each subarc. A zero entry indicathat so SVIC applies.	⇒ t	/GLOBAL/(721	ARCIN 1	IMERFL
INDF		M State variable inequality constraint flag. INOF = D: No SVIC In effect; INOF = I: Dynamic pressure IC in effect INOF = 8: Heating rate SVIC in effect; INOF = 9: Reynalds number SVIC in effect		/DYNA /(185)	ARCIN M MPLAME M	Tuef Inof
1908		A Powered flag. IPOW = 0: No thrust and no base drag IPOW = 1: Thrust, but ne base drag IPOW = 2: Thrust and base drag		/DYNA /(139)	ARCIB A FORCES I NPLANE 1 STATEF I THROTL 1	1905 1908 1908 1908 1908
RAYED		0 18 of the nazioum rated ISP	(SECS)	/DYNA /(110)	ARCIN G	IRATED IRATED
ISP	I ST	O Vecuum specific impulse	(SECS)	/DYMA /(45)	APPLY 1 ARCIA 0 IMPULS 0	15P 15P 15P
JAER :		l Aerodynamic model option flag		/ARCDAT/(9)	AERDED 1 ARCIN 1 OUTPUT 1 STATEF 1 UT 1	RSAL RSAL RSAL RSAL RSAL
JFRO		1 Propulsion model option flag		/ARCDAT/(10)	ARCIN I IMPULS I	JPRO JPRO
11		O Thrust option fing. J1 = 1: Constant thrust; J1 = 2: Input vacuum thrust; J2 = 3: Powered total acceleration finity J3 = 4: Air-breether englag.	t,	/DYNA /(173)	APPLY I ARCIN O CONTRL M FORCES I MPLANE I STATEF I THROTE M	J1 J1 J1 J1 J1 J1

FORTRAM Symbol	MATH Symbol	CODE	DESCRIPTION	BLOCA	ORAC	LOC	SUBROUTI	NE USAGI
J2		0	Engine deflection aption flag.	/DYNA	/(174)	ARCIN O	
13		0	J2 = 1: Constant angine deflection; J2 = 2: Moment balancing.		,,	1751	MPLANE I	JŽ
			Angle of attack option fing. J3 = 1: Optimal angle of attack; J3 = 2: Constant angle of attack; J3 = 3: Untriamed lift limit; J3 = 4: Vertical rise or pitchever; J3 = 5: Unpowered total acceleration limit; J3 = 6: Gravity turn; J3 = 7: Dynamic pressure constraint; J3 = 8: Heating rate constraint; J3 = 9: Reynolds number constraint.	/DYNA		-	CONTRL P NPLANE R OUTPUT I	13 1 13 1 13
KODE		0	Stearing vector flag KODE = 0: Free fall, $\alpha = \theta = 0$, KODE = 1: Both α and θ optimal; KODE = 2: α optimal and $\theta = 0$; KODE = 3: α nonoptimal and θ optimal; KODE = 4: Vertical rise or pitchover; KODE = 5: α nonoptimal and $\theta = 0$.	/DYNA	/(25)	APPLY I ARCIN D CONTRL M FORCES I NLDRY I STATEF I	KODE KODE KODE
KONVER		t	Logical flag that indicates to the QL module that the QL iteration is converged.	/CNTRL	/(28)	ALGCON I APPLY I ARCIN I COHOMO O GROPE O NLORY I OUTPUT I RKUTTI I	KOMAEL KOMAEL KOMAEL KOMAEL KOMAEL
LGAM	λ,	1	Relative flight path angle costate.	/8	/(101)	ALI I ARCIN I CONTRL I NLDRY I OUTPUT I WRAPUP I	LGAM
LPSI	$\lambda_{m{\phi}}$	1	Relative azimuth angle costate	/8	/(1021	ALI I ARCIN I CONTRL I NLDRV I OUTPUT I WRAPUP I	LPSI LPSI
MDB		1	Curve number - base drag table	/ARCBAT	7/(31)	ARCIN I STATEF I	
MISP		1	Curve number kISP loss table	/ARCDAT	7/(26)	ARCIN I IMPULS I	
AT		i	Curve number -thrust table	/ARCDAT			ARCIN I	
ATT	_	• • •	Table number for tabulated rocket vacuum thrust	/QYNA			STATEF I	TTM
PG	٠,	8	See symbol	/MATS	/(551)	AL4 M APPLY I ARCIN O CONTRL O	P 6
PLG	* \(\lambda_{\begin{subarray}{c} \lambda_{\b	0	See symbol	/MATS	/(570)	APPLY 1 ARCIN 0 CONTRL 0	
PLP	*x*	0	See symbol	/MATS	/(571)	APPLY I ARCIN D CONTRL D	PLP
SREF	S _{ref}	Ī	Aerodynamic reference area (FT ²	ARCDAT	T/(1)	ARCIN I BNDRY I CHECK I FETCH I SALVE I STATEF I UT I WRAPUP I	ARCDA SREF SREF

FORTRAN -	MATH	CODE DESCRIPTION	J	STORAL		SUBROUTIN	
SYMBOL	SYMBOL	DESCRIPTION		BLOCK	LOC	SUBR COO	E VAR
	T	O Thrust	(LBS)	/DYNA /(42)	ALGCON FALL I AL4 I AL7 I AL7 I AL8 I AL9 I APCIN CONTRL FOLL I I OUTPUT I THI	; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ;
TMULT	T _{muit}	I Thrust multipiler or number of engin-		/ARCDAT/(4)	ARCIN I STATEF I	THULT
TSTAGE		M Trajectory time at which present rocking nited.	ket engine (SECS)	/DYNA /(167)	ARCIN M STATEF I TRAJIN O	TSTAGE TSTAGE TSTAGE
TSTART		M Trajectory time at which present sub	arc commenced.	/DYNA /(141)	ARCEN M ARCIN M STATEF I TRAJIN D	TSTART TSTART TSTART TSTART
XARC	-	O Quasitime at which present-subare co	menced.	ZDYNA · /(140)	ARGIN O Statef I	XARC XARC
XISP '	Isp	I Vacuum specific impulse	(SEC)	/ARCDAT/(31	ARCIN I	XISP XISP
XJ	j	O Control blend factor		/DYNA /(159)	ARCIN O DL2 I OUTPUT I STATEF I UT I	x) x) x) x)
XX		O Fraction of subarc that has transpire	ed .	/DYNA /(1)	ARCIN O ERROR 1 OUTPUT 1	XX



Purpose

Given the matrix A in Equation 16.6-29 in Vol. I, BASIS determines the matrix A^{\star} in Equation 16.6-33 in Vol. I.

```
SIS(A, M, M)

GIVEN A SET OF M LINEARLY INDEPENDENT ROW VECTORS IN BASIS
THE EUCLIDEAN SPACE E**N, WHICH ARE STORED IN THE
FIRST M ROWS OF THE MATRIX A, THIS ROUTINE GENERATES BASIS
A SET OF M LINEARLY INDEPENDENT ROW VECTORS IN E**N.
BASIS
N), LNZE(30)
ROW REDUCE THE FIRST M ROWS OF A
BASIS
BASIS
BASIS
BASIS
BASIS
BASIS
BASIS
BASIS
                                  SUBROUTINE BASIS(A, M, M)
 1.
2.
3.
4.
5.
6.
7.
8.
                000000
                                 DIMENSION A(N, N), LNZE(30)
ROW REDUCE THE FIRST M ROWS OF A

DD 105 1 = 1, M

D0 104 J = 1, N

FIND LEADING NON-ZERO ENTRY IN I-TH ROW

IF(ABS(A(I, J)).LE. 0.) GO TO 104

STORE COLUMN NUMBER IN WHICH LEADING NON-ZERO OCCURS
                C
 BASIS
BASIS
BASIS
BASIS
                C
                                                                                                                                                                                                                                                                164-
                C
                                  LNZE(I) = J
                                                                          NORMALIZE I-TH ROW BY LEADING NON-ZERO ENTRY
                                                                                                                                                                                                                                        BASISS
BASISS
BASISS
BASISS
BASISS
BASISS
BASISS
BASISS
BASIS
BASIS
                C
                                 NORMALIZE

FMZE = A(I, J)

D0 101 K = 1, M

A(I, K) = A(I, K)/FMZE

A(I, J) = 1
                      101
                                                                          ANNIHILATE NON-ZERO ENTRIES ABOVE AND BELOW LEADING NON-ZERO.
               ç
                     NON-ZERO.

DO 103 K = 1, M

IF(K .EQ. 1) 60 TO 103

IF(ABS(A(K, J)) .LE. 0.) 60 TO 103

AKJ = A(K, J)

DO 102 L = 1, M

102 A(K, L) = A(K, L) - AKJ+A(I, L)

A(K, J) = 0

103 CONTINUE

60 TO 105
 30.
31.
                                                                                                                                                                                                                                        BASIS
BASIS
                                                                                                                                                                                                                                                                105-
                                                                                                                                                                                                                                        BASIS
32.
                      104 CONTINUE
                                                                                                                                                                                                                                       BASIS
                     105 CONTINUE
33.
35.
35.
37.
38.
40.
41.
42.
45.
                                                                          GENERATE REMAINING N \sim A ROW VECTORS BY STORING A ONE IN THOSE COLUMNS THAT OO NOT CONTAIN A LEADING NON-ZERO ENTRY.
                     L = M + 1

MA = M

DD 108 I = L, M

DD 107 J = 1, M

DD 106 K = 1, MA

106 IF(LAZE(K) .EG. J) 60 TO 107

A(I J) = 1

LNZÉ(I) = J

MA = MA + 1

GO TO 108
                                                                                                                                                                                                                                                                107-
                                                                                                                                                                                                                                                                108-
47.
                     107 CONTINUE
                                                                                                                                                                                                                                        BASIS
48.
49.
50.
                     108 CONTINUE
RETURN
END
                                                                                                                                                                                                                                        BASIS
BASIS
BASIS
```



SUBRØUT I NE BCØND

Purpose

BCOND sets up the state initial conditions block IIC and the state target conditions blocks ITC and JTAB.

```
SUBROUTINE BCOMD
                  1.
2.
3.
4.
5.
6.
7.
                                 20200
                                                                                                                   THIS ROUTINE SETS UP THE STATE INITIAL CONDITIONS BLOCK IIC AND THE STATE TARGET CONDITIONS BLOCKS ITC AND JTAB
                                                      8.
              10.
11.
12.
13.
            13.
14.
15.
16.
17.
18.
19.
                                                      COMMON/GLOBAL/

*GR 7ER OMGZ ,XLAMAF, YMURF ,LUM ,TO EPSLON, INNER *ITRMAX, JDOP(6) ;FATAL, NARC ,NBRAN ,NFARC ,ID(4) ,XTAB(20), SIG, MAXTAB GM, PSIÁF, IPFLG1, IPFLG2, IPFLG3, IPFLG4, *INEGFL(20) , ITPSO ,KSOL , INARK ,KGLOBL(7) ,COMMON /BLÓCK, IIC(10 , 20) ,ITC(10 , 20) ,ITC(10 , 20) ,JTAB(20), *ITCT(10 , 20) ,LTAB(20), NOKNOM, NOC(20), VALIC(10 , 20) ,VALIC(10 , 20) ,IPAY REAL MAGBY, MU, M, LY, LGAM, LPSI, LB, LRHO, LMU, LM, LTAU, NOM , LHT ,COMMON /D/
            21.
22.
23.
24.
25.
26.
27.
28.
                                                   REAL MAGÉV, MÚ, M, LV, LGAM, LPSI, LB, LRHO, LMU, LM, LTAU, NOM LHT
COMMON /D/
*X H, XI(4), MAGBV, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI, *ALT, RHO, MU, M, TAU, HT, LV, LGAM, LPSI, LR LRHO, LMU, LM, LTAU, *CHT, D109, D110, 8V(40), ZSAVE(20), Of(20), NPOINT(20), DELT(20)
DIMENSION NOM(20)
EDUJVALENCE (NDM, V)
DIMENSION CONDS(400), FIC(1), FTC(1), FTRNS(1), INTR(17), INTR(17), ISD(17), ISTATE(12), ITRNS(24), JTC(12), KTC(12), *MTC(1), VTC(1) TABLE(1)
EQUIVALENCE (FIC, CONDS), (FTC, CONDS(301)), (VTC, ITC(51)), *MTC(1), VTC(1) TABLE(1)
EQUIVALENCE (FIC, CONDS), (FTC, CONDS(301)), (VTC, ITC(51))
OATA NS/97, INTR/8, 1, 2, 4, 7, 3, 5, 6, 0, 9, 0, 21, 0, 24, 29, 2*0/
*ISD/128, 1 2, 8, 64, 16, 32, 0, 25, 0, 31, 0, 32, 0/, *FLSHFT/N, 09627, 2, 8, 64, 1, 1, 2, 4, 7, 3, 5, 6, 9, 21, 0, 24, 29, 2*0/
*FLSHFT/N, 09627, 2, 4, 8, 16, 32, 64, 128, 256, 3*0/, *FLSHFT/N, 09627, 2, 438336, 2, 86037, 98325, 1, 524336, 1, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 98324, 438336, 1, 438336/, *413697, 2, 50, 16, 11, 1/, 2, *86VNDS/6N BCOMD/
IARC = I

SET INTEGRATION CONTROL PARAMETERS SO THAT SUBROUTINES ARCIN AND ARCEN MILL RE CALLED BY FORCES MEN
            29.
30.
          31233356789G123456789G123
                                                                                                                 SET INTEGRATION CONTROL PARAMETERS SO THAT SUBROU-
TINES ARCIN AND ARCEN WILL BE CALLED BY FORCES WHEN
FETCH CALL FORCES.
                                2000
                                                         KPT = 1
NPTS = 1
                                                         READ INITIAL AND TARGET CONDITIONS INTO ARRAY CONDS CALL READMS(9, CONDS, 400, 21)
CLEAR STATE INITIAL AND TARGET CONDITION BLOCKS
                               C
          55.
55.
56.
57.
58.
                               C
                                       DO 101 I = 1, 9

DO 101 J = 1, N

IIC(I, J) = 0

ITC(I, J) = 0

VALIC(I, J) = 0

101 VALTC(I, J) = 0
                              ç
                                                                                                                 GET INITIAL VALUE OF STATE AND COSTATE OFF THE INITIAL ARC FILE
          61.
62.
63.
64.
65.
66.
67.
70.
71.
72.
73.
                                                         CALL FETCH(0)
                               C
                                                                                                                 STORE INITIAL STATE AND COSTATE
                                       DO 102 I = 1, 18
102 ZSAVE(I) = NOM(I)
d
                                                                                                                ÎNÎTIALIZE FIRST COLUMN OF IIC TO KNOWN CONDITION
9
                              C
                                       103 110(1, 1) = 1
d
                              C
                                                       INDX = -2
JNDX = -1
DD 109 IARC = 1
STORE NUMBER OF STATED INITIAL CONDITIONS FOR THIS
                                                                                                                INTERPRET INPUT CONDITIONS
                              ç
```

BCOND CNTRL CNTRL CNTRL CNTRL CNTRL GLOBAL GLOBAL GLOBAL BLOCK BLOCK DD DD

BCOND

BCOND BCOND

BCOND

BCOND BCCOND BCCOND

BCOND

BCOND



```
NOSIC = ITAB(IARC)
IF(NOSIC .LE. 0) GO TO 105
INTERPRET THE STATED INITIAL CONDITIONS
DO .104 I= 1, NOSIC
INDX = INDX + 3
ICODE = FIC(INDX) + .5
IF(ICODE .GE. 10) ICODE = 0
JVN = FIC(INDX + 1) + .5
TRANSLATE STEEP. DESC. VARIABLE NO. TO OL NO.
IVN = INTR(JVN)
                                                                                                                                                                                                                                    BCOND
         76.
778.
79.
81.
82.
84.
85.
86.
88.
                                                                                                                                                                                                                                   BCOND
BCOND
BCOND
BCOND
                                                                                                                                                                                                                                                          105-
                      C
                                                                                                                                                                                                                                    BCOND
                                                                                                                                                                                                                                   BCOND
BCOND
BCOND
BCOND
                       C
                       C
                                        TRANSLATE STEEP. DESC. VARIABLE NO. TO CIVN = INTR(JVM)

SKIP INIT. COND. ON TRAJ. TIME

IF(IVN .EQ. 0) 60 TO 104

IIC(IVN, IARC) = ICODE

CONVERT DESIRED VALUE TO INTERNAL UNITS

VALIC(IVN, IARC) = SOMG(JVN, FIC(IMDX + 2))
                                                                                                                                                                                                                                    BCOND
BCOND
BCOND
BCOND
                       C
                                                                                                                                                                                                                                                         104-
         89.
90.
91.
                      C
                                                                                                                                                                                                                                   BCOMD
          92
                            104 CONTINUE
                                                                                                                                                                                                                                   BCOND
          93.
                       C
                                                                               STORE NUMBER OF TARGET CONDS. FOR THIS ARC
                                                                                                                                                                                                                                   BCOND
                                        NMBR = KTAB( IARC )
          94.
                                                                                                                                                                                                                                   BCOND
                                       MMBR = KTAB(IARC)

1 = 0

IF(MMBR .LE. 0) GO TO 108

INTERPRET TARGET CONDS.

DO 107 I = 1, MMBR

JNDX = JNDX + 2

FWRD = ABS(FTC(JNDX))

IWRD = 1.E-6*FWRD + .5

GWRD = IWRD

JWRD = FWRD - 1.E6*GWRD + .5

CHECK FOR PAYOFF CONDITION

IF(JWRD .LT. 2) GO TO 106

IPAY = 1WRD

GO TO 107
         95.
                                                                                                                                                                                                                                   BCOND
      95.
96.
97.
98.
99.
100.
101.
                                                                                                                                                                                                                                   BCOND
BCOND
BCOND
                                                                                                                                                                                                                                                          108
                    ¢
                                                                                                                                                                                                                                  BCOND
BCOND
BCOND
BCOND
BCOND
      103.
104.
105.
106.
107.
                                                                                                                                                                                                                                   BCOND
BCOND
                      C
                                                                                                                                                                                                                                                         106
                                                                                                                                                                                                                                   BCOMB
                                                                                                                                                                                                                                   BCOND
     108.
109.
110. C
                           106 L = L + 1

ITC(L, IARC) = IWRD

CONVERT DESIRED VALUE TO INTERNAL UNITS

VALTC(L, IARC) = SOMG(IWRD, FTC(JNDX + 1))
                                                                                                                                                                                                                                   BCOND
                                                                                                                                                                                                                                   BCOND
                                                                                                                                                                                                                                   BCOND
                                                                                                                                                                                                                                   BCOND
     112.
                            107 CONTINUE
                                                                                                                                                                                                                                   BCOND
                      C
                                                                               STORE ACTUAL NUMBER OF TARGETS IN JTAB
                           108 JTAB(IARC) = L

MAKE SURE PAYOFF WAS ON LAST ARC

109 IF(L .LT. MMBR .AND. IARC .NE. NARC) CALL ERROR(XBCNDS, -1, 1)

SUPERINDESE INPUT INITIAL GROSS MASS

1F(IIC(7, 1) .EQ. 1) ZSAYE(7) = VALIC(7, 1)

DETERMINE THE COSTATE INITIAL AND TARGET CONDITIONS
                                                                                                                                                                                                                                   BCOND
     114.
115. C
116.
117. C
118.
119. C
                                                                                                                                                                                                                                   BCOND
                    С
                                                                                                                                                                                                                                   BCOND
BCOND
                                                                                                                                                                                                                                  BCOND
BCOND
BCOND
                           CALL MAGIC

STORE TRANSVERSALITY CONDITIONS FOR END OF LAST BRANCH

MA = 9 - JTABL NARC)
DO 110 I = 1, MA
110 ITCT(I, NARC) = I
LTAB(NARC) = MA

TEST FOR BRANCH PROBLEM

IF(NFARC .EQ. NARC) RETURN
STORE TRANSVERSALITY CONDITIONS FOR END OF FIRST BRANCH
MA = 9 - JTABL NFARC)
                                                                                                                                                                                                                                   BCOND
     121.
122.
123.
                     C
                                                                                                                                                                                                                                  BCOND
BCOND
BCOND
123.
124.
125.
126.
127.
128.
129.
130.
                                                                                                                                                                                                                                  BCOND
BCOND
BCOND
                     C
                                                                                                                                                                                                                                  BCOND
                                                                                                                                                                                                                                  BCOND
BCOND
                            MA = 9 - JTAB(NFARC)
DO 111 I = 1 MA
111 ITCT( NFARC) = I
LTAB(MFARC) = MA
RETURN
                                                                                                                                                                                                                                  BCOND
     132.
133.
134.
135.
                                                                                                                                                                                                                                   BCOND
d
                                                                                                                                                                                                                                  BCOND
                                                                                                                                                                                                                                   RCOND
      136.
                                        END
                                                                                                                                                                                                                                   BCOND
```

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORAGE BLOCK LOC	SUBROUTINE USAGE SUBR CODE VAR
IARC	1	M Subarc nymber		/CNTRL /(24	BCOND M IARC BCOND M IARC BNDRY M IARC BRANPT I IARC CHECK M IARC COSTAB I IARC COSTAB I IARC ENDPT I IARC FORCES I IARC INARC M IARC MARGIC M IARC MARGIC M IARC GLTOSZ I IARC GLTOSZ I IARC SALVE M IARC WARPUP M IARC
110		codes for the	containing the initial condition QL state vector. The columns subarc starting points, the rows, to ables.	/8LOCK /(1	BCOND M IIC BRAMPT I IIC CHECK I IIC COSTAB I IIC COSTAB I IIC COSTAO I IIC INTRPT I IIC SALVE I IIC
I NDX	-	Moulton Integ	our mords that indicate to Adams- ration in mhat order the derivatives ular and homogeneous solutions are	/CNTRL /(11) BCOND M INDX MADAMS M INDX SALVE O INDX
ITAB			my containing the number of nonzero conditions specified at the beginning c.	/GLOBAL/(45) BCOND I ITAB
ITC		codes for the	containing the Initial condition QL costate vector. The columns subarc starting points, the roms, to riables.	\BFOCK \(40)	BCOND O ITC BRAMPT I ITC CHECK I ITC COSTAB I ITC COSTAB I ITC COSTAB I ITC ENDPT I ITC INTRPT I ITC
ITCT		the array IIC end points. the numbers of Equation 16.6 that contain	containing the QL costate analog to I. The columns correspond to subarc like nonzero entries in a column are fithose components of the vector O in -34 of Yolume I of the PADS document the value of a costate target tapplies at the end of the subarc.	/BLOCK /(621	BCOMD O ITCT BRANPT I ITCT CHECK I ITCT COSTAB O ITCT COSTAB O ITCT INTAPT I ITCT MAGIC O ITCT
JTAB			sining the number of nonzero entries n of the array IICT.	/BLOCK /(601	BCOND M JTAB BRANPT I JTAB CHECK I JTAB COSTAB I JTAB COSTAB I JTAB COSTAI I JTAB ENDPT I JTAB INTRPT I JTAB MAGIC I JTAB
KPT		O The subarc po point of subar of the subarc.	int number. KPT = 1 on the first rc, and KPT = MPTS on the last point	/CMTRL /(8	BOOND O KPT BADRY O KPT FORCES I KPT MAGIC O KPT RKUTTI I KPT SALVE M KPT WRAPUP M KPT
KTAB		I A 20 word arra target conditi subarc.	ey containing the number of state ions specified at the end of each	/GLOBAL/(25) BCOND I KTAB



	FORTRAN Symbol	MATH SYMBOL	CODE	DESCRIPTION	STC BLOCK	RAGE LOC	SUBROUTINE US
	LTAB		0	An array containing the number of nonzero entries in each column of the array ITCT.	/8LOCK	/4 821	BCOND O LTA BRANPT 1 LTA COSTAB O LTA COSTAI O LTA INTRPT 1 LTA MAGIC M LTA
	NARC	N _S		Number of subarcs in the problem.	/GLOBAL		BCOND I WAR BNDRY I MAR CHECK I MAR ENDPT I MAR ENVPRO I MAR FETCH I MAR INARC I MAR MAGIC I MAR GLTOSZ I MAR GLTOSZ I MAR SALVE I MAR WARPUP I MAR
	NF AR C	N ₂	I	Number of the last subarc on the first branch. If the problem is not a branch problem, then NFARC = MARC.	/GLOBAL	/(20:	BCOND I MFA BNDRY I MFA BRAMPT I MFA COSTAB I MFA ENVPRO I MFA INTRPT I MFA MAGIC I MFA OLTOSZ I MFA SALVE I MFA
<u>.</u> .	M OM	V	1	Relative velocity. (FT/SEC)	/ Đ <u>.</u>	/(911	ALI I V AL4 - I V AL7 I V AL8 I V AL9
	NPTS		0	The total number of points in the subarc.	/CNTRL	/(19)	BCOND O NPT BNDRY O NPT FORCES I MPT INARC M NPT MAGIC O NPT SALVE M MPT WRAPUP O NPT
	VALIC			A 10×20 array containing the desired values of all the fixed (known) 9L state variables. The columns correspond to the subarc starting points, the rows, to 9L state variables.	/BLOCK	(862)	BCOND M VAL Salve I VAL
	VALTC		0	A 10x20 array containing the desired values of the state target conditions shose codes appear in the array IICT.	/BLOCK	(1062)	BCOND O VAL' BRANPT I VAL' CHECK I VAL' ENDPT I VAL' INTRPT I VAL'
	ZSAVE		0	A twenty word array containing the values from the initial arc of the state and costate at the initial point of the trajectory.	/0	(151)	BCOND 0 ZSA BRANPT 1 ZSA COSTAB I ZSA COSTAI 1 ZSA INTRPT I ZSA INTRPT I ZSA SALVE I ZSA

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6 DCT 72 G.01-44

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SUBRØUT INE BLINE

Purpose

BLINE interpolates the bivariate tabular functions. In addition, it computes the first and second partials of these functions by evaluating the derivatives of the bicubic spline interpolating function.*

^{*}See Section 17.7 of Vol. I.

```
BLINE
                                   SUBROUTINE BLINE(A, M, U)
 1234567890112345611189012223456
                                                                            THIS ROUTINE COMPUTES THE BIVARIATE AERODYNAMIC LIFT AND DRAG COEFFICIENTS AND THEIR FIRST AND SECOND PARTIALS. A IS THE CURRENT ANGLE OF ATTACK, M IS MACH AND U = CL, CLA, CLM, CLAA, CLMM, CLAM, CLAM, CLAM, CLAM, CDAM, CDAM, CDAM, CDAM, CDAM, CDAM
                    CU, CDA, CDA, CDAA, CDAA, CDAA

REAL M, K, MMIN, MMAX, MACH
COMMON /BICUBE/ AMIN AMMAX, IF, IFMAX, MMIN, MMAX, IR, IRMAX,
*IUNIT, IRECT, IRECC, (32), T(160), KNDTS(1)

DIMENSION U(12), ALFA(1), MACH, KNDTS(32))

EQUIVALENCE
*(CLOC, C(1)), (CLO1, C(5)), (CLO2, C(9)), (CLO3, C(13)),
*(CLO, C(1)), (CLO1, C(6)), (CLO2, C(10)), (CLO3, C(14)),
*(CLOC, C(3)), (CLO1, C(6)), (CLO2, C(10)), (CLO3, C(15)),
*(CLOC, C(3)), (CLO1, C(6)), (CLO2, C(11)), (CLO3, C(15)),
*(CLOO, C(17)), (CDO1, C(2)), (CDO2, C(25)), (CDO3, C(29)),
*(CDO0, C(17)), (CDO1, C(21)), (CDO2, C(25)), (CDO3, C(29)),
*(CDO0, C(19)), (CDO1, C(22)), (CDO2, C(25)), (CDO3, C(30)),
*(CDO2, C(19)), (CDO1, C(23)), (CDO2, C(27)), (CDO3, C(30)),
*(CDO3, C(20)), (CDO1, C(24)), (CDO2, C(28)), (CDO3, C(32))

SEE IF MACH IS WITHIN RANGE

SEE IF MACH IS WITHIN RANGE
                                                                                                                                                                                                                                             BLINE
                                                                                                                                                                                                                                                                     101-
                                                                            SEE IF ALPHA IS WITHIN RANGE
                     10) IF(AMIN .LE. A .AND. A .LE. AMAX) GO TO 103

NO. FORCE ALPHA TO APPROPRIATE LIMIT.

IF(A .LT. AMIN) A = AMIN

IF(AMAX .LT. A) A = AMAX

FIND LARGEST MACH ENTRY .LE. CURRENT MACH NO.
 27.
28.
29.
30.
                                                                                                                                                                                                                                             BLINE
BLINE
BLINE
BLINE
                                                                                                                                                                                                                                                                      103
 31.
                                                                                                                                                                                                                                                                                                                    109
 32.
                      103 IF(M - MACH(IR)) 104, 109, 105
                                                                                                                                                                                                                                              BLINE
                                                                                                                                                                                                                                                                    104-105
 33.
34.
                     104 IR = IR - 1
60 TO 103
                                                                                                                                                                                                                                             BLINE
                                                                                                                                                                                                                                                                                                      103
                      105 IF(M - MACH(IR + 1)) 109, 106, 107
106 IF(IR .GE. IRMAX) 60 TO 109
                                                                                                                                                                                                                                                                                                                     109-
 35.
                                                                                                                                                                                                                                                                    106-107
                                                                                                                                                                                                                                             BLINE
                                                                                                                                                                                                                                                                                                                    109
 36.
                                                                                                                                                                                                                                             BLINE
 37.
38.
                      107 IR = IR + 1
GO TO 103
                                                                                                                                                                                                                                             BLINE
                                                                                                                                                                                                                                                                    103
39.
                      109 IF(A - ALFA(IF)) 110, 114, 111
                                                                                                                                                                                                                                             BLINE
                                                                                                                                                                                                                                                                    110-111
                      110 IF = IF - 1
60 TO 109
 40.
                                                                                                                                                                                                                                             BLINE
                                                                                                                                                                                                                                                                                                                     109-
 41.
42.
                                                                            FIND LARGEST ALPHA ENTRY .LE. CURRENT ALPHA
                     111 IF(A - ALFA(IF + 1)) 114, 112, 113
112 IF(IF .GE. IFMAX) 60 TO 114
                                                                                                                                                                                                                                             BLINE
                                                                                                                                                                                                                                                                    112-113-
                                                                                                                                                                                                                                                                                                    114-
 43.
                                                                                                                                                                                                                                                                                                  4114-
44.
                                                                                                                                                                                                                                             BLINE
                      113 IF = IF + 1
60 TO 109
                                                                                                                                                                                                                                             BLINE
 45.
                                GMCH(IR)

FIND APPROPIATE GRID RECTANGLE AND STORE ITS SPLINE
COEFFICIENTS IN C ARRAY. NOTE EACH RECORD CONTAINS
FIVE RECTANGLES

JRECT = IR + IRPAIX*(IF - 1)

IF(JRECT .EQ. IRECT) GO TO 117

JRECT = JRECT

JRECT = 1)/5 + 2

IF(JREC .EQ. IRECT)
 46.
                                                                                                                                                                                                                                             BLINE
                      114 H = A - ALFA(1F)
K = M - MACH(1R)
                                                                                                                                                                                                                                             BLINE
 48.
49.
50.
51.
52.
53.
55.
56.
57.
                                                                                                                                                                                                                                             BLINE
BLINE
BLINE
               CCC
                                                                                                                                                                                                                                            BLINE
BLINE
BLINE
BLINE
BLINE
                                                                                                                                                                                                                                                                     117-
                                 IRECT = JRECT

JREC = (IRECT - 1)/5 + 2

IF(JREC .EQ. IREC) 60 TO 115

IREC = JREC

CALL READMS(IUNIT, T, 160, IREC)
                                                                                                                                                                                                                                                                     115-
                                                                                                                                                                                                                                             BLINE
                     115 18 = 32*(IRECT - 5*IREC + 9)

00 116 I = 1, 32

J = I + 18

116 C(I) = T(J)
60.
61.
62.
63.
                                                                                                                                                                                                                                             BILLNE
                                                                                                                                                                                                                                             BLINE
                                                                                                                                                                                                                                            BLINE
BLINE
BLINE
BLINE
BLINE
64.
65.
66.
67.
                      117 CONTINUE
                                 CLO = CLOO + K*(CLO1 + K*(CLO2 + K*CLO3))
CL1 = CL1O + K*(CL11 + K*(CL12 + K*CL13))
CL2 = CL2O + K*(CL21 + K*(CL22 + K*CL23))
CL3 = CL3O + K*(CL31 + K*(CL32 + K*CL33))
```



```
69. C

70. U(1) = CLO + M*(CL1 + M*(CL2 + M*CL3))

71. CDO = CD00 + K*(CD01 + K*(CD02 + K*CD03))

72. CD1 = CD10 + K*(CD11 + K*(CD12 + K*CD13))

73. CD2 = CD20 + K*(CD11 + K*(CD12 + K*CD13))

74. CD3 = CD30 + K*(CD21 + K*(CD22 + K*CD23))

75. C

COMPUTE CD

76. U(7) = CD0 + M*(CD1 + K*(CD12 + K*CD3))

77. CLOPP = K*CLO3

78. CLOPP = K*CLO3

79. CLOP = CLO1 + K*(CL02 + CLOPP)

80. CLIPP = K*CL13

81. CLIPP = CLIPP + CLIPP + CLIPP + CL12

82. CLIP = CL1P + K*(CL12 + CLIPP)

83. CL2PP = K*CL23

84. CL2PP = K*CL23

85. CL2P = CL2P + CL2PP + CL2PP + CL2P

85. CL2P = CL2P + K*(CL22 + CL2PP)

86. CL3PP = K*CL3

87. CL3PP = K*CL3

88. CL3P = CL31 + K*(CL12 + CL3PP)

88. CL3P = CL31 + K*(CL12 + CL3PP)

89. UXX = H*CL3

89. UXX = H*CL3

90. UXX = H*CL3

91. C

102 = CL1 + M*(CL12 + UXX)

93. U(3) = CL0P + H*(CL1P + M*(CL2P + H*CL3P))

94. CD0PP = K*CD03

95. CD0PP = CD0PP + CD0PP + CD0PP + CD02

97. CD1PP = K*CD13

98. CD1P = CD11 + K*(CD12 + CD1PP)

99. CD1P = CD11 + K*(CD12 + CD1PP)

99. CD1P = CD11 + K*(CD12 + CD1PP)

100. CD2PP = K*CD31

101. CD2PP = K*CD31

102. CD3P = K*CD31

103. CD3PP = K*CD31

104. CD3PP = K*CD31

105. CD3P = K*CD31

106. VXX = H*CG3

107. CMPUTE CDA AND CDM

108. C COMPUTE CDA AND CDM

109. U(8) = CD1 + M*(CD2P + CD3PP + CD3PP)

110. U(9) = CD0P + H*(CD1P + H*(CD2P + H*CD3PP))

111. C U(4) = UXX + VXX + VXX + VXX + CD2

103. CD3PP = CO3PP + CD3PP + CD3PP + CD3PP

104. CD3PP = CD3PP + CD3PP + CD3PP + CD3PP

105. CD3P = CD31 + K*(CD32 + CD3PP)

106. CD3P = CD31 + K*(CD32 + CD3PP)

107. CD3P = CD31 + K*(CD32 + CD3PP)

108. CD3P = CD31 + K*(CD32 + CD3PP)

109. U(9) = CD0P + H*(CD1PP + H*(CD2P + H*CD3PP))

110. U(9) = CD0P + H*(CD1PP + H*(CD2P + H*CD3PP))

111. U(5) = UYX + VXX

112. U(4) = UXX + VXX

113. UYY = CD0PP + H*(CD1PP + H*(CD2PP + H*CD3PP))

114. U(5) = CU1P + H*(CD2P + CD2PP + H*CD3PP)

115. U(1) = VXX + VXX

116. C

117. U(1) = VXX + VXX

118. UYY = CD0PP + H*(CD1PP + H*(CD3PP + H*CD3PP))

129. U(1) = CD1P + H*(CD2PP + CD2PP + H*CD3PP)

121. RETURM

122. END
```

BLINE BLINE BLINE

BLINE BLINE BLINE

BLINEE BLINEE

BLINE BLINE BLINE

BLINE BLINE BLINE BLINE

BLINE BLINE BLINE BLINE BLINE BLINE BLINE

BLINE BLINE BLINE BLINE BLINE BLINE BLINE



ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORA BLOCK	LOC			E USAGE E VAR
ALFA		1	A 31 word array containing the mesh x_0, x_1, \dots, x_n	/BICUBE/(204)	BLINE	1	ALFA
AMAX	×N	1	The largest value of the first independent variable of a bivariate table.	/BICUBE/(2)	BLINE	I	AMAX
AMI N	×o	1	The smallest value of the first independent variable of a bivariate table.	/BICUBE/(1)	BLINE	1	AMIN
C		0	A 32 word array containing the spline coefficients for the two bivariate functions at rectangle IRECT.	/BICUBE/(12)	BLINE BLINE	0 1	C C C
CLOO		I	A 32 word array containing the spline coefficients for the two bivariate functions at rectangle IRECT.	/BICUBE/(12)	BLINE BLINE	1	CF00 C
IF '		M	Last flie in the grid in which interpolation occurred.	/BICUBE/(3)	BLINE	Ħ	IF
FMAX	N	I	Total number of files in grid.	/BICUBE/(- 4)	BLINE	I	IFMAX
18		п	Last rank in the grid in which interpolation occurred.	/BICUBE/(7)	BLINE	M	J R
IREC		-	Logical record on IUNIT that contains spline coefficients for rectangle IRECT.	/BICUBE/(11)	BLINE	A	IREC
IRECT			Grid rectangle associated with IR and IF.	/BICUBE/(10)	BLINE	M	IRECT
RMAX		ī	Total number of ranks in grid.	/BICUBE/(8)	BLINE	3	IRMAX
UNIT		I	Logical unit number on which bicubic spline coefficients are stored for this table.	/BICUBE/(9)	BLINE	I	IUNIT
4ACH		I	A 31 word array containing the mesh yo, y ₁ ,,y _n	/BICUBE/(235)	BLINE	ī	MACH
X APIP	У _М	1	The largest value of the second independent variable of a bivariate table.	/BICUBE/(. 6).	BLINE	ī	KAMM
9PE 20	y _O	1	The smallest value of the second independent variable of a bivariate table.	/BICUBE/(5)	BLINE	I	MMIN
ŗ		I	A 160 word array containing logical record IREC.	/BICUBE/(44)	BLINE	1	T



SUBRØUT I NE BNDRY

0.01

Purpose

BNDRY controls the computation of the state and costate target misses and the partials of these misses with respect to the c's.*

^{*}See Sections 16.6 and 17.4 of Vol. I.

```
THIS ROUTINE CONTROLS THE COMPUTATION OF THE STATE AND COSTATE TARGET MISSES AND THE PARTIALS OF THOSE MISSES WITH RESPECT TO THE MULTIPLIERS OF THE MOMOGRAPHOUS SOLUTIONS, OR CS, FOR SHORT. THE PARTIALS ARE STORED IN DPZIOC. THE MISSES, IN PZ.

**SREF**

**SREF**

**JATE**

**TATE**

                                                                                                                                                                                                                                                                                                                                                                                                                           BNDRY
 1.
2.
3.
4.
5.
6.
7.
8.
10.
112.
134.
115.
                             000000
                                                                                                                                                                                                                                                                                                                                                                                                                           BNDRY
BNDRY
BNDRY
                                                                                                                                                                                                                                                                                                                                                                                                                           BNDRY
BNDRY
ARCDAT
                                                 ARCDAT
                                                                                                                                                                                                                                                                                                                                                                                                                         ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
 18.
19.
20.
                                                                                                                                                                                                                                                                                                                                                                                                                          EVAL
EVAL
GLOBAL
                                                                                                                                                                                                                                                                                                                                                                                                                         GLOBAL
GLOBAL
GLOBAL
GLOBAL
CNTRL
CNTRL
CNTRL
CNTRL
21.
22.
23.
24.
25.
26.
27.
28.
29.
30.
31.
32.
 33.
34.
35.
                                                                                                                                                                                                                                                                                                                                                                                                                            JUL21
36.
37.
38.
39.
                                                                                                                                                                                                                                                                                                                                                                                                                           BLOCK
41.
42.
43.
44.
45.
47.
                                                                                                                                                                                                                                                                                                                                                                                                                          BLOCK
                                                                                                                                                                                                                                                                                                                                                                                                                         PC
                                                                                                                                                                                                                                                                                                                                                                                                                        PC
BNDRY
BNDRY
BNDRY
BNDRY
BNDRY
BNDRY
                                                                                                                                   SET INTEGRATION CONTROL FLAGS SO THAT FORCES WILL CALL ARCEN AND ARCIN
489...
50...
51...
52...
55...
55...
55...
55...
56...
                          Ç
                                                          KPT = 1
NPTS = 1
                                                                                                                                                                                                                                                                                                                                                                                                                         BNORY
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
BNDRY
BNDRY
                           C
                                                                                                                                    INITIALIZE NUMBER OF TARGET MISSES COMPUTED SO FAR
                                                          L = 0
                                                                                                                                   SET PAYOFF SIGN
                          C
                                                         SGN = SIGN(1., SIE)
DO 105 IARC = 1, MARC
READ IN THE DATA FOR THIS SUBARC
CALL READMS(9, ARCDA, 42, IARC)
SET INDEPENDENT VARIABLE
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
BNDRY
                                                                                                                                                                                                                                                                                                                                                                                                                         JUL19B
JUL19B
JUL21
BNDRY
                          C
                           C
                                                                                                                                    STORE NUMBER OF C+S THAT HAVE INFLUENCE ON THIS ARC
                           C
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
                                                        STORE NUMBER OF C+S THAT HAVE INFLUENCE ON THIS ARC MOCK = MOC(IARC)

NO = MOC(IARC)

NN = N+(NOCK + 1)

COMPUTE RECORD SIZE FOR THIS ARC

NN = N+(NOCK + 1)

COMBINE UP TOTAL SOLUTION CORRESPONDING TO THE LAST POINT OF THIS ARC AND STORE IN NOM ARRAY

CALL READRS(41, S, NN, 2+IARC)

CALL MATHLT(Z, S(1, 2), C, 18, MOCK, 1)

CALL MATADD(Z, Z, 5, 18, 1)

DO 101 J = 1, 18

MOM(I) = Z(I)

CALL FORCES

IS THIS THE LAST ARC
62.
63.
64.
65.
66.
67.
70.
71.
72.
73.
                                                                                                                                                                                                                                                                                                                                                                                                                          BADRY
                           C
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
BNDRY
                           Ç
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
BNDRY
BNDRY
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
                                                          IS THIS THE LAST ARC
IF(IARC .EQ. NARC) GO TO 104
NO. IS THIS A BRANCH PROBLEM.
                          ε
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
                                                                                                                                                                                                                                                                                                                                                                                                                         BNDRY
BNDRY
                          ε
```

```
IF(NFARC .LT. NARC) GO TO 103
INTERMEDIATE POINT.
      76.
77.
                                                                                                                                                                                BNDRY
BNDRY
               ε
      78.
79.
80.
                     102 CALL INTRPT(DPZIDC, K)
GO TO 105
                                                                                                                                                                                BNDRY
BNDRY
BNDRY
                                                            IS THIS THE LAST ARC OF THE FIRST BRANCH
                     103 IF(IARC .EQ. NFARC) GO TO 104
NO. IS THIS THE BRANCH POINT
IF(IARC .NE. MBRAN) GO TO 102
YES. BRANCH POINT
CALL BRANPT(DPZIDC, K)
GO TO 105
END POINT.
     81.
82. C
83.
84. C
85.
86.
                                                                                                                                                                               BNDRY
BNDRY
BNDRY
BNDRY
BNDRY
BNDRY
BNDRY
                                                                                                                                                                                                                          104-
                                                                                                                                                                                                102
                                                                                                                                                                                                 105
                                                            END POINT.
                    MAKE SURE NUMBER OF MISSES COMPUTED = NUMBER OF C+S.

IF(L .NE. K) CALL ERROR(BNDRYX, -1, 1)

MOVE MISSES TO OUTPUT ARRAY

106 PZ(I) = PZI(I)

RETURN
END
     88.
                                                                                                                                                                                BNDRY
              105 CONTINUE
C
                                                                                                                                                                               BADRY
BNDRY
BNDRY
BNDRY
BNDRY
BNDRY
BNDRY
BNDRY
BNDRY
     89.
90.
91.
92.
93.
94.
95.
d
```



FORTRAN Symbol	MATH Symbol	000	E DESCRIPTION	BLOC	K	GE LOC	SUBROU'	TINE USA CODE VA
ARCDA	S _{ret}	Î	Aerodynamic reference area (FT ²)	/ AR CDA	NT/(1)	UT	I SREF I ARCD I ARCD I ARCD I SREF I SREF I ARCD
C	t	ī	A forty mord array containing the vector of c's, i.e. the multipliers for the homogeneous solutions.	/D	/(11)	BNDRY BRANPT GROPE INTRPT NEWCS NLDRY NOMNAL	I C I C I C
OC	Δc;	D	Small perturbation of a c.	/EVAL	/(867)		D DC . I DC .
IARC	I	A	Subarc number.	/CNTRL	. 10	24)	BCOND BNDRYT CHECK COSTAB COSTAB ENDPT FORCES INTRPT MARCH MARCH SALVE	M IARC I IARC I IARC
KPT		0	The subarc point number. KPT = 1 on the first point of subarc, and KPT = NPTS on the last point of the subarc.	/CNTRL	/(8)	BNDRY FORCES MAGIC RKUTT1	M KPT
L		A	Tatal number of target conditions to satisfy in the problem.	/EVAL	/(868)	BRANPT	M L
MAP		D	A 10 word array that maps the steepest descent state vector into the QL state vector.	/EVAL	/(20)	BRANPT	D MAP I MAP I MAP I MAP
•		Ī	Total number of QL state and costate variables. M = 18.	/PC	/(2)	CHECK INARC LINDRY NLDRY NOMNAL RKUTTI	I W I W I W

FORTRAN,	MATH			î n Ni		GE	SUBROU	TINE USA
SYMBOL	SYMBOL		DESCRIPTION		BLOCK	LOC	SUBR	CODE VAI
NARC	Na	1	Number of subarcs in the problem.		/GLOBAL/(18)	BCOND BNDRY CHECK ENDPT ENVPRQ FETCH INARC MAGIC QLTOSZ SARPUP	I NARC I NARC I NARC I NARC
NBRAN -	N ₁	I	Number of the last subarc on the stem of a problem. If the problem is not a branch at then MBRAN = 0.	branch problem,	/GLOBAL/(19)	BNDRY BRANPT COSTAB ENVPRO INTRPT MAGIC QLTOSZ	I NBRAI I NBRAI I NBRAI I NBRAI I NBRAI
NF AR C	^N 2	1	Number of the last subarc on the first brathe problem is not a branch problem, then MARC.		/GLOBAL/(BCOND BNDRY BRANPT COSTAB ENVPRO INTRPT MAGIC OLTOSZ SALVE	I NFARC I NFARC I NFARC I NFARC
NN		, n	The number of quantities currently being numerically integrated.		/CNTRL /(52)	BNDRY INARC MADAMS MAGIC NOMNAL RKUTT1 RKUTT2 SALVE WRAPUP	M NN I NN I NN I NN
MO C		I	An array containing a running total of the of free (unknown) state and costate variable start of each subarc.		/BLOCK /{	842)	BNDRY BRANPT COSTAB COSTAI COSTAG INARC INTRPT SALVE WRAPUP	0 NOC 0 NOC 1 NOC 1 NOC 1 NOC
NOCK	• I	n	The number of c's in the vector \mathbf{C}_1 defined Equation 17.4-4 of Vol.i of this document.	by	/EVAL /(70)		M NOCK I NOCK I NOCK I NOCK
NO PI	V		Relative velocity.	(FT/SEC)	/D /(ALT ALT ALB ALB BCOND BNDRYT CONTRL ENOPT ENOPT FETCH INTERPT INTERPT NLORY NLORY NLORY NLORY STATEF	I V I V I V I V I V I V I V I V I V I V

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		STORAGE		SUBROUTINE USAS		
			DESCRIPTION	BFOCK	LQC	SUBR	COD	E VAI	
MPTS		0	The total number of points in the subarc.	/CNTRL	/(19	BCOND BNDRY FORCES INARC MAGIC SALVE WRAPUP	M 0 M	NPTS NPTS NPTS NPTS NPTS NPTS	
PZI		1	A 40 word array that contains the target condition misses for all the target conditions in the problem.	/EVAL	/(30	BNDRY BRANPT ENDPT INTRPT	A	PZI PZI PZI PZI	
5		1	An 18x41 array used to store the particular and homogeneous solutions on the early side of a corner point.	/EVAL	/(1)	BNDRY BRANPT ENDPT INTRPT	1	\$ \$ \$ \$	
SGM		0	Sign of the variable SIG in the 65th mord of common block /60BAL/. SGN = +: payoff to be maximized; SGN = -: payoff to be minimized.	/EVAL	/(1	BNORY ENDPT	0 J	S GN S GN	
\$16		t	Payoff sign. SIG < 0: Payoff to be minimized; SIG > 0: Payoff to be maximized.	/GLOBAL	./(65	BNDRY	I	516	
SPART		D	An 18 mord array whose first nine entries receive the values of the partial derivatives art the state of those target conditions computed in subroutine PDBCQL.	/EVAL	/(2	BNDRY BRANPT ENDPT Intrpt	D I I	SPART SPART SPART	
	x	O	The quasitise variable.	/D		MADAMS RKUTT1 RKUTT2 SALVE	RIMMERI	X	
•	Z	ī	A 20 mord array used to store the total linear solution from the preceding QL iteration.	/2	/C 1	BNDRY BRAMPT ENDPT ENVPRO INTERP INTERP INTERP LIMDRY NOMNAL OUTPUT RKUTT! RKUTT! SALVE WRAPUP	I I R I O M		

SUBRØUT I NE BRANPT



BRANPT evaluates the state and costate target misses at a branch point and their partials with respect to the c's.*

See Sections 16.6 and 17.4 of Vol. I.

```
BRANPT
BRANPT
BRANPT
BRANPT
                         SUBROUTINE BRANPT(DPZIDC, KK)
     00000
                                                THIS ROUTINE EVALUATES THE STATE AND COSTATE TARGET MISSES AT A BRANCH PT. AND THE PARTIALS OF THOSE MISSES W/RESP. TO THE C+S
                      BRAMPT
                         REAL_MAGBY, MU, M, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM
                                                                                                                                          JUL21
                                                                                                                                         CMTRL
CMTRL
CMTRL
CMTRL
CMTRL
CMTRL
CMTRL
GLOBAL
                                                                                                                                         GLOBAL
GLOBAL
GLOBAL
GLOBAL
     22.
223.
224.
225.
227.
229.
331.
334.
356.
                                                                                                                                        BLOCK
BLOCK
BLOCK
EVAL
EVAL
BRAMPT
                                                                                                                                         BRANPT
BRANPT
BRANPT
BRANPT
BRANPT
BRANPT
     BRANPT
                                                                                                                                         JUL19B
BRANPT
     41.
42.
43.
44.
45.
46.
47.
48.
                                                                                                                                         BRANPT
                CONDITIONS ON THE STATE

DO 102 J = 1, 27

00 102 J = 1, 27

102 AB(I, J) = 0'

DO 114 J = 1, 9

FIRST ARC OF FIRST BRANCH

IF(IIC(I, KARC) - 1) 103, 104, 105

CONTINUOUS STATE
BRAMPT
                                                                                                                                         BRANPT
                                                                                                                                         BRANPT
                                                                                                                                                      103-7104-7105
                 103 MA = MA + 1

AB(MA, I + 9) = 1

AB(MA, I + 18) = -1

GO TO 108
     50.
51.
                                                                                                                                         BRANPT
                                                                                                                                         BRAMPT
     52.
53.
54.
                                                                                                                                         BRANPT
                                               KNOWN STATE
                                                                                                                                         BRANPT
                 104 MA = MA + 1
AB(MA, I + 9) = 1
60 TO 108
     55.
56.
57.
                                                                                                                                         BRANPT
BRANPT
                                                                                                                                                                                 108
                                                                                                                                         BRANPT
                 105 IF(IIC(I, KARC) - 5) 108, 106, 107
KNOWN DROP WEIGHT
     58.
59.
                                                                                                                                                              107-108
                                                                                                                                         BRANPT
                                                                                                                                                      106-
                                                                                                                                         BRANPT
                 60.
61.
62.
63.
                                                                                                                                         BRAMPT
                                                                                                                                         BRANPT
                                                                                                                                         BRANP1
                107 MAJE MA + 1
WPRO = GR+(ZSAVE(T) - M)
CALL MTDRP(WPRO, WDRP, DWDRP, 3)
AB(MA, I + 9) = -1
AB(MA, I + 18) = 1. - DWDRP
FIRST ARC OF SECOND BRANCH
                                               SIZING DROP WEIGHT
                                                                                                                                         BRAMPT
                                                                                                                                         BRANPT
BRANPT
BRANPT
     65.
     66.
67.
68.
69.
10.
                                                                                                                                         BRAMP
                                                                                                                                         BRANPT
                 108 IF(IIC(I, LARC) - 1) 109, 110, 111
CONTINUOUS STATE
     71.
                                                                                                                                         BRANPT
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```
109 MA = MA + 1

AB(MA, I) = 1

AB(MA, I + 18) = -1

GO TO 114
                                                                                                                                                                                                                                                                                                                                                                          BRANPT
             74.
75.
76.
77.
                                                                                                                                                                                                                                                                                                                                                                           BRANPT
                                                                                                                            KNOWN STATE
                                                                                                                                                                                                                                                                                                                                                                           BRANPT
              78.
79.
80.
                                             110 MA = MA + 1
AB(MA, I) = 1
GO TO 114
                                                                                                                                                                                                                                                                                                                                                                          BRANPT
BRANPT
BRANPT
                                            111 IF(31C(1, LARC) - 5) 114, 112, 113
Known drop weight
                                                                                                                                                                                                                                                                                                                                                                                                                                    113
                                                                                                                                                                                                                                                                                                                                                                                                                                                          114
              81
                                                                                                                                                                                                                                                                                                                                                                          RRANPT
                                                                                                                                                                                                                                                                                                                                                                                                             112-
                                                                                                                                                                                                                                                                                                                                                                           BRANPT
                                              112 MA = MA + 1
              83.
                                                                                                                                                                                                                                                                                                                                                                          BRANPT
              84.
85.
86.
                                                              AB(MA, 1) = -1
AB(MA, 1 + 18) = 1
GO TO 114
                                                                                                                                                                                                                                                                                                                                                                          BRANPT
BRANPT
BRANPT
                                            113 MA = MA + 1

1F(IIC(I, LARC) .LT. 7) 60 TO 1131

WEIGHT DISTRIBUTION FROM STEM TO BRANCHES.

AB(MA, I) = -1

AB(MA, I + 9) = -1

AB(MA, I + 18) = 1

GD TO 114
              87.
                                                                                                                                                                                                                                                                                                                                                                          BRANPT
              88.
89.
90.
91.
                                                                                                                                                                                                                                                                                                                                                                          BRANPT
BRANPT
BRANPT
                                                                                                                                                                                                                                                                                                                                                                                                             1131
                                    C
                                                                                                                                                                                                                                                                                                                                                                           RRAMPT
                                    Ċ
                                                                                                                           SIZING DROP WEIGHT
              94.
                                                                                                                                                                                                                                                                                                                                                                          BRANPT
              95.
96.
97.
98.
                                       1131 WPRO = GR*(ZSAVE(7) - M)
CALL WTDRP(WPRO, MDRP, DMDRP, 3)
AB(MA, I) = -1
AB(MA, I + 18) = 1. - DMDRP
                                                                                                                                                                                                                                                                                                                                                                          BRAMPT
                                                                                                                                                                                                                                                                                                                                                                          BRANPT
                                                                                                                                                                                                                                                                                                                                                                          BRAMPT
         99.
100.
101.
                                                                                                                                                                                                                                                                                                                                                                          BRANPT
                                            114 CONTINUE
60 TO LABL
                                                                                                                                                                                                                                                                                                                                                                         BRANPT
BRANPT
BRANPT
BRANPT
BRANPT
BRANPT
                                           ARE THERE ANY STATE TARGET CONDITIONS TO BE SATIS-
FIED AT THE END OF THE STEM
ARE THERE ANY COSTATE TARGETS TO BE SATISFIED
115 IF(MTARG .LE. O) GO TO 121
YES. ADD ROWS TO AB MATRIX THAT RESULT FROM STATE
TARGET COMDITIONS. AT THE SAME TIME, EVALUATE THESE
TARGETS MISSES AND THEIR PARTIALS M/RESP. TO C.S.
                                  CCC
        102.
103.
104.
105.
                                                                                                                                                                                                                                                                                                                                                                                                             121
                                  000
        106.
107.
108.
109.
110.
111.
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BRANPT
BRANPT
                                         TARGETS MISSES AND THEIR PARTICLE TO THE TOTAL THE TOTAL THE TOTAL THE TOTAL THE TARGET MISS PLICE TO THE TOTAL THE TO
                                                                                                                                                                                                                                                                                                                                                                         BRANPT
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BRANPT
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        113.
114.
115.
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BRANPT
BRANPT
                                 C
115.
116.
117.
118.
119.
120.
                               C
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BRANPT
BRANPT
                                                                                                                                                                                                                                                                                                                                                                          ARAMP1
      121.
                                                                                                                                                                                                                                                                                                                                                                                                                                     120-
                                                                                                                           COMPLEX CONDITION ON THE STATES
                                                                                                                                                                                                                                                                                                                                                                         BRANPT
                                            117 ISKIP = Q
      123.
                                          117 ISKIP = 0
CALL PDBCOL(KODE, VAL, SPART, RUMMY, 1, ISKIP)
DD 118 J = 1, 9

118 AB(MA, J + 18) = SPART(J)
COMP. AND STORE TARGET MISS.
PZI(K) = VAL - VALTC(I, NBRAN)
COMP. AND STORE PARTS.W/RESP.TO C+S OF TARGET MISS
CALL MATMLT(TEMP, SPART, S(1, 2),1, 18, NOCK)
119 J = 1, NOCK
119 DPZIDC(K, J) = TEMP(J)
120 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                         REAMPT
123.
124.
125.
126.
127. C
128.
129. C
                                                                                                                                                                                                                                                                                                                                                                         BRANPT
                                                                                                                                                                                                                                                                                                                                                                         BRANPT
BRANPT
BRANPT
                                                                                                                                                                                                                                                                                                                                                                        BRANPT
        130.
                                                                                                                                                                                                                                                                                                                                                                         BRANPT
BRANPT
C131
      T133.
                                           120 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                         BRANPT
                                  C
                                                                                                                            ARE THERE ANY COSTATE TARGET CONDITIONS
                                           PARE INERE HAT SOUTH

121 IF(NTARG .LE.O) 60 TO 141

YES. COMPLETE AND INVERT AB MATRIX

CALL BASIS(AB, MA, 27)

CALL GJRV(AB, 27, 1.E-12, 1ERR)

SET UP THE BB VECTOR SO THAT THE TRANSVERSALITY

CONDITIONS CAN BE EVALUATED
      135.
136.
137.
138.
139.
140.
141.
                                                                                                                                                                                                                                                                                                                                                                         BRANPT
                                                                                                                                                                                                                                                                                                                                                                       BRANPT
BRANPT
BRANPT
BRANPT
BRANPT
BRANPT
BRANPT
                                 C
                                 C
                                                             KNOCK = NOC(KARC)
KROCK = NOC(LARC)
```

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```
CALL READMS(41, SI, 18*(KNOCK + 1), 2*NBRAM + 1)
CALL MATMLT(ZZ, SI(1, 2), C, 18, KNOCK, 1)
CALL MATADD(ZZ, ZZ, SI, 18, 1)
CALL READMS(41, SB, 18*(KROCK + 1), 2*NFARC + 1)
CALL MATMLT(ZZ, SB(1, 2), C, 18, KROCK, 1)
CALL MATADD(ZZZ, ZZZ, SB, 18, 1)
DO 12Z I = 1, 9
J = I + 9
BB(1) = -ZZZ(J)
BB(J) = -ZZZ(J)
12 BB(J) + 9) = NDM(J)
I = MA + 1
I = 27 - MA
IP = L + MTARG

COMP. THE TRANSVERSALITY CONDITIONS
CALL MATMLT(VAL, BB, ABC), IF), 1, 27, IL)
STORE THE NON-TRIVIAL TRANSVERSALITY CONDITIONS AS
COSTATE TARGET MISSES
J = ITCT(I, MBRAM)
K = IP + 1

123 PZI(K) = VAL(J)

COMPUTE THE PARTS.M/RESP.TO THE C*5 OF THE COSTATE
TARGET MISSES
                                                                                                                                                                                                                                                                                           BRANPT
                                     143.
144.
145.
146.
147.
148.
150.
151.
152.
153.
155.
156.
162.
163.
164.
165.
166.
171.
172.
173.
174.
175.
                                                                                                                                                                                                                                                                                           BRANPT
BRANPT
BRANPT
BRANPT
                                                                                                                                                                                                                                                                                           BRAMP
                                                                                                                                                                                                                                                                                           BRANPT
BRANPT
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                                                                                                                                                                                                                                                                                          BRANPT
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                                                                                                                                                                                                                                                                                          BRANPT
BRANPT
BRANPT
                                                                                                                                                                                                                                                                                          BRANPI
                                                                                                                      COMPUTE THE PARTS.M/RESP.TO THE C+5 OF THE COSTATE TARGET MISSES
                                                                                                                                                                                                                                                                                          BRANPT
BRANPT
BRANPT
                                                        Ç
                                                                         TARGET MISSES

1, KROCK
1, KROCK
1, COMPUTE THE STATE/COSTATE PERT. RESULTING FROM PERT.
OF THIS C.

CALL MATMLT(DI, SB1, IC + 1), DC, 18, 1, 1)
ADD STATE/COSTATE PERT. TO BASE VALUE OF STATE/COSTATE VECTOR

CALL MATADD(ITM, ZZZ, DZ, 18, 1)
IF(IC - KNOCK - 1) 124, 125, 127
THIS C HAS AN EFFECT ON THE FIRST BRANCH. COMP. ITS
EFFECT ON THE STATE/COSTATE VECTOR AT THE START OF
THE FIRST BRANCH.
                                                                                                                                                                                                                                                                                          BRANPT
BRANPT
BRANPT
                                                                                                                                                                                                                                                                                          BRAMPI
                                                                                                                                                                                                                                                                                        BRAMPT
BRAMPT
BRAMPT
BRAMPT
BRAMPT
BRAMPT
BRAMPT
BRAMPT
                                                        C
                                                                                                                                                                                                                                                                                                                                   125
                                                                                                                                                                                                                                                                                                                                                  127
                                                              124 CALL MATMLT(DZ, S1(1, 1C + 1), DC, 18, 1, 1)
CALL MATADD(TOM, ZZ, DZ, 18, 1)
60 TO 127
                                     178.
179.
180.
181.
182.
183.
                                                                                                                                                                                                                                                                                          BRANPT
                                                                                                                                                                                                                                                                                         BRANPT
BRANPT
BRANPT
BRANPT
BRANPT
BRANPT
                                                                                                                                                                                                                                                                                                                                                  127
                                                                                                                     THIS C AND ALL SUBSEQUENT C+S IN THIS LOOP ARE TO HAVE NO EFFECT ON THE FIRST BRANCH. RESTORE THE STATE/COSTATE VECTOR AT THE START OF THE FIRST BRANCH TO ITS BASE VALUE.
                                                                                                                                                                                                                                                                                          BRANPT
                                     185.
186.
                                                               125 DO 126 I = 1,
126 TOM(I) = ZZ(I)
                                                                                                                                                                                                                                                                                          REAMPT
                                                                                                                     - 1) 128, 129, 132
This C has an effect on the stem. Comp. 115 effect
On the state/costate vector at the end of the stem
                                     187.
                                                               127 IF(IC - NOCK -
                                                                                                                                                                                                                                                                                          BRANPT
                                                                                                                                                                                                                                                                                                                                                   132
                                                                                                                                                                                                                                                                                          RRAMPT
                                    190.
191.
192.
193.
194.
195.
                                                              128 CALL MATMLT(DZ, S(1, 1C + 1), DC, 18, 1, 1)
CALL MATADD(NDM, Z, DZ, 18, 1)
60 TO 131
                                                                                                                                                                                                                                                                                          BRANPT
                                                                                                                                                                                                                                                                                          RRAMPT
                                                                                                                                                                                                                                                                                         BRANPT
BRANPT
BRANPT
                                                                                                                                                                                                                                                                                                                  131
                                                                                                                     THIS C AND ALL SUBSEQUENT C+S IN THIS LOOP ARE TO HAVE NO EFFECT ON THE STEM. RESTORE THE STATE/CO-STATE VECTOR AT THE END OF THE STEM TO ITS BASE VAL
                                                                                                                                                                                                                                                                                        BRANPT
                                q 137:
                                                              129 DO 130 I = 1,
130 NOM(1) = Z(1)
                                                                                                                                                                                                                                                                                         BRANPT
                                     198.
199.
                                                              131 CALL FORCES
                                                                                                                                                                                                                                                                                         BRANPT
                                                                                                                     RECOMPUTE BB VECTOR
                                                                                                                                                                                                                                                                                          BRANPT
                                                            BRANPT
                                    200.
                                    200.
201.
202.
203.
204.
205.
206.
207.
                                                                                                                                                                                                                                                                                          BRANPT
                                                                                                                                                                                                                                                                                        BRAMPT
BRAMPT
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BRAMPT
BRAMPT
BRAMPT
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                                  207.
208.
209.
210.
211.
212.
213.
214.
                                                                                                                                                                                                                                                                                                                  138
                                                                                                                                                                                                                                                                                        BRANPT
BRANPT
BRANPT
                                                                                                                                                                                                                                                                                          BRANP
                                                                                                                                                                                                                                                                                         BRANPT
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```
AB(MA, KODE + 18) = 1

60 TO 137

135 ISKIP = 0

CALL POBCOL(KODE, VAL, SPART, RUMMY, 1, ISKIP)

DO 136 J = 1, 9

136 AB(MA, J + 18) = SPART(J)
215.
216.
217.
218.
219.
220.
                                                                                                                                            BRANPT
Branpt
                                                                                                                                            BRANPT
BRANPT
BRANPT
BRANPT
137 CONTINUE
                                                                                                                                            BRANPT
   221.
                                                                                                                                           BRANPT
                                                INCREMENT THE NUMBER OF STATE/COSTATE TARGET MISSES EVALUATED SO FAR
  235.
236.
237.
                141 L = L + MTARG + NTARG
RETURN
END
                                                                                                                                            BRANPT
BRANPT
BRANPT
```

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FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION	STORAGE BLOCK LOC	SUBROUTINE USAG SUBR CODE VAR
				
C	c	I A forty mord array containing the vector of c's, i.e. the multipliers for the homogeneous solutions.	/D /(11	DENDRY I CERTAIN I C
DC	Δε	1 Small perturbation of a c.	/EVAL /(867) BNDRY D DC BRANPT I DC ENDPT I DC INTRPT I DC
DZ	Δc (h (1 -)	I An 18 word array that contains the second term on the right hand side of Equation 17.4~11 of Voi.I of this document.	/EVAL /(849) BRANPT I DZ ENDPT I OZ INTRPT I DZ
GR	gr	I Gravitational acceleration at surface of the earth. (FT/SEC ²)	/GLOBAL/(1	ALS I GR APPLI I GR BRANPT I GR COSTAB I GR COSTAB I GR INTRPT I GR CUTPUT I GR PUBCOL I GR QLTOSZ I GR SALVE I GR STATEF I GR TM3 I GR
IARC -	ī	1 Subarc number.	/CNTRL /(24)	ARCIN I LARC BCOND M LARC BNORY M LARC BRAMPT I LARC CHECK M LARC COSTAB I LARC COSTAB I LARC ENDPT I LARC FORCES I LARC INTARC M LARC INTART I LARC MAGIC M LARC MAGIC M LARC QLTOSZ I LARC SALVE M LARC BRAPUP M LARC
116 .		I A 10×20 array containing the initial condition codes for the QL state vector. The columns correspond to subarc starting points, the rows, to QL state variables.	/BLOCK /(1)	BCOND M IIC BRANPT 1 IIC CHECK 1 IIC COSTAB I IIC COSTAD 1 IIC COSTAD 1 IIC COSTAD 1 IIC INTRPT I IIC
ITC		I A 10×20 array containing the initial condition codes for the QL costate vector. The columns correspond to subarc starting points, the roms, to QL costate variables.	/BLOCK /(401)	BCOND O ITC BRANPT I ITC CHECK I ITC COSTAB I ITC COSTAB I ITC COSTAB I ITC ENDPT I ITC INTRPT I ITC
ІТСТ		A 10x20 array containing the QL costate analog to the array IICT. The columns correspond to subarc end points. The nonzero entries in a column are the numbers of those components of the vector O in Equation 16.6-34 of Volume I of the PADS document that contain the value of a costate target condition that applies at the end of the corresponding subarc.	/BLOCK /(621)	BCOND 0 ITCT BRANPT I ITCT CHECK I ITCT COSTAB D ITCT COSTAI 0 ITCT INTRPT I ITCT PAGGIC 0 ITCT

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ORTRAN	MATH	CODE	DESCRIPTION	STORA			INE USAG
SYMBOL	SYMBOL		DE33111 11010	BLOCK	LOC	SUBR C	ODE VAR
JTAB			array containing the number of nonzero entries each column of the array IICT.	/BLOCK /(601)	BRANPT CHECK COSTAB COSTAI ENDPT INTRPT	I JTAB
.			al number of target conditions to satisfy in the biem.	/EVAL /(868)	BRAMPT	M L M L M L
LTAB 			erray containing the number of nonzero entries each column of the array ITCT.	\BFOCK \(821)	BRANPT : COSTAB (COSTAI (INTRPT)	LTAB
•	•	1 Res	s (6'5)	/D /(97)	AL4 AL7 AL8 AL9 APPLY BRANPT COSTAB COSTAB INTRPT BLDRY	# # # # # # # # # # # # # # # # # # #
MAP	•	 I A 1	O word array that maps the steepest descent	/EVAL /(20)	OUTPUT I SALVE I STATEF I WRAPUP I BNDRY	R R
			te vector into the QL state vector.			BRANPT I ENDPT I INTRPT I	MAP
NBR AM	N ₁ .	pro	ber of the last subarc on the stem of a branch blem. If the problem is not a branch problem, n NBRAN = 0.	/6L0BAL/(19)	BNDRY I BRANPT I COSTAB I ENVPRO I INTRPT I MAGIC I QLTOSZ I SALVE I	NBRAN NBRAN NBRAN NBRAN NBRAN
NFARC	N ₂		ber of the last subarc on the first branch. If problem is not a branch problem, then MFARC = C.	/GLOBAL/(20)	BCOND I BNDRY I BRANPT I COSTAB I ENVPRQ I INTRPT I MAGIC I QLTOSZ I SALVE I	NFARC NFARC NFARC NFARC NFARC NFARC
NO C		of '	array containing a running total of the number free (unknown) state and costate variables at start of each subarc.	/BLOCK /(BNDRY I BRANPT I COSTAB O COSTAI O COSTAO O INARC I INTRPT I SALVE I WRAPUP I	NOC NOC NOC NOC NOC NOC
IO CK	æ I		number of c's in the vector \mathbf{C}_{T} defined by ation 17.4-4 of Vol.i of this document.	/EVAL /(BNDRY M BRANPT I ENDPT I INTRPT I	NOCK

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FORTRAN SYMBOL	MATH Symbol	CODE	DESCRIPTION) N	BLOCK	DRAGE LDC	SUBROUTI SUBR CO	
NOR	V	A Relative ve	locity.	(FT/SEC)	/B	. 91	AL1 I AL7 I AL7 I AL8 I AL9 I BCOND I BNDRY O BRAMPT M CONTRL I ENUPT I ENUPT I ENUPT I ENUPT I ENUPT I OINTERP M INTERP M INTERP O NLDRY O OUTPUT I PUBCOL I STATEF I WRAPUP I	V V V V V V V V V V V V V V V V V V V
PZI			rray that contains the all the target conditio		/EVAL	/(30)	BNDRY I BRANPT M ENDPT M INTRPT M	PZI PZI PZI PZI
s .	•		ay used to store the p solutions on the early		/EVAL	/(71)	BNDRY I BRANPT I ENDPT I INTRPT I	\$ \$ \$ \$
\$1	,		ay used to store the p solutions on the late		/EVAL	/(869)	BRANPT I INTRPT I	51 51
SPART		the values o	erray whose first nine of the partial derivati get conditions compute	ves prt the state	/EVAL	/(2)	BNORY D BRANPT I ENDPT I INTRPT I	SPART SPART SPART SPART
TEMP	(94 ¹ \9C ¹) _⊥		ray that contains the ned by Equation 17-4-9		/EVAL	/(809)	BRANPT I ENDPT I INTRPT I	TEMP TEMP TEMP
VALTC		I A 10x20 arra state target array 11C1.	y containing the desir: conditions whose code	ed values of the s appear in the	/8LOCK	/(1062)	BCOND O BRANPT I CHECK I ENDPT I INTEPT I	VALTC VALTC VALTC VALTC VALTC
Z	2		ray used to store the in the preceding QL item		/1		BNDRY I BRANPT I ENDPPRO I INTERP O INTERP I INTERP I NOMNAL M OUTPUT I RKUTTZ M SALVE M SALVE M WRAPUP M	
ZSAVE		initial arc	d array containing the of the state and costate trajectory.		۵/	/(151)	BCOND O BRANPT I COSTAB I COSTAB I INTRPI I PDBCOL I SALVE I	ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE

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SUBRØUT I NE CHECK



Purpose

CHECK initializes the flags and parameters needed by QL module to carry out the integration and solution of the trajectory optimization problem.

```
CHECK
CHECK
CHECK
CHECK
CHECK
CHECK
CHECK
                                   PROGRAM
                                                                    CHECK
  2.
3.
4.
5.
6.
7.
8.
                 000000
                                                                             THIS ROUTINE HANDLES THE INITIALIZATION OF THOSE FLAGS AND PARAMETERS THAT ENABLE OL TO CARRY OUT THE INTEGRATION AND SOLUTION OF THE OPTIMIZATION
                                                                              PROBLEM.
                               COMMON/ORBIT/VI,

* ECC, AINCL,

* PERGEE, ANOMLY,

* HMNTM, DVIDV,

* DVIDH, DVIDH,

* DPIDH, DGIDH,

* DPIDH, DPIDG,

* DPIDH, DMIDN',

* DPIDH, DMIDN',

* DPIDH, DMIDH,

* DPIDH, DMIDH,

* DPIDH, DMIDH,

* DPIDH, DMIDH,

* DECDM, DECDPS,

* DIDH,

* DBEDG, DBEDH,

* DNODN, DSMDV,

* DNODN, DSMDV,

* DSMDV,

* DSMDV,

* DSMDV,

* DSMDV,

* DSMDV,
                                                                                                    GAMI,
ARGP,
CAPX,
DVIDG,
DVIDPS,
                                                                                                                                                                 SMIMAJ,
SMIMAJ,
ASYMP,
                                                                                                                                  ASCNOD,
                                                                                                                                                                                               APOGEE,
ENERGY,
                                                                                                                                                                                                                                            ORBIT
                                                                                                                                                                                                                                           ORBIT
ORBIT
ORBIT
                                                                                                                                  DVIDEG.
                                                                                                                                                                 DVIDMU,
                                                                                                                                                                                                 DGIDV
                                                                                                DVIDPS,
DGIDM,
DFIDM,
DFIDG,
DFDWU
DECORD,
DIOPS,
DNODH,
DSMDG,
                                                                                                                                  DGIOPS,
                                                                                                                                                                                              DGIDMÚ,
DPIDRO,
DMIDPS,
DPDM
DECDH,
DIDG
DBEDV
                                                                          DGIDH,
DPIDG,
DMIDV,
DMIDMU,
                                                                                                                                                                DGIDRO,
DPIDPS,
DMIDM
                                                                                                                                                                                                                                           ORBIT
ORBIT
ORBIT
ORBIT
                                                                                                                                  DPIDM
DMIDH
DPDG
DECDV
                                                                                                                                                            DPDH , DECDG , DIDV , DIDMU , DBEDRO,
                                                                         DMIDMU,
DPDRO,
DECDPS,
DIDM,
DBEDH,
DNOOG,
                                                                                                                                                                                                                                           ORBIT
ORBIT
ORBIT
ORBIT
                                                                                                                               DECDMU,
DIDRO
DBEDPS,
  18.
19.
20.
21.
                                                                                                                                                                                                DBEDMU,
DNODRO,
                                                                                                                                                                                                                                           ORBIT
ORBIT
ORBIT
ORBIT
                                                                          DNODG
DSMDV,
                                                                                                                                  DNODM
                                * DNODWU,
COMMON/ORBIT/
* DSMORO, D
* DAPOPS, D
                                                                                                                                    DSMDH,
                                                                                                                                                                                              DSMDPS
                                                                      DSMDAU.
                                                                                                                                                                   DAPDH,
                                                                                                                                                                                              DAPDM ,
                                                                                                       DAPDV
                                                                                                                                     DAPDG.
                                                                                                                                                                                             DAPOM,
OPECH,
DCXDW,
DCXDW,
OCXDMU,
OCYDRO,
DASDPS,
DENOM,
DMODH,
                                                                   DSMDMU,
DAPDRO,
DPEDPS
DANDH
DCYDG
DASDV
DASDMU,
DENDRO,
DMDRO,
                                                                                                                                   DAPDG,
DPEDV,
DPEDMU
DANDRO,
DCYDM
DCYDM
DASDH,
DENDG,
DMODV,
DMODMU
                                                                                                                                                                  DAPDN,
DPEDG,
DANDV
DANDMU,
DCXDRO,
DCYDPS,
                                                                                                 DAPDMÚ,
DPEDRO
DANDPS,
DCXDM,
                                                                                                                                                                                                                                          ORBIT
                               DAPOPS,
DPEDM
DANDH
DCXDG
DCYDV
DCYDMU,
DASDRO,
DENDPS,
DMODM
                                                                                                       DCYDH
                                                                                                                                                                  DASDM ,
DENDH ,
DMODG ,
                                                                                                       DASDG ,
                                                                                                       DENDMU,
                                 DANDM DANDPS, DENDRO, DENDRO, DRODAU,
DIMENSION ORBERM(18), PPO(7,18)
EQUIVALENCE (V1) ORBERM) (DVIDV.PPO)
COMMON/ORBIT/ YMXRF, SNXLMR, CSXLMR, SDOWN, SCROSS, TD, TC
, SNFSR , CSFSR , SAGI , CSGI , SPSII
, STOT , CSI , SNGNU , CSAMO
SINDMU , THT , WTFUEL
 34.
35.
36.
37.
                                                                                                                                                                                                    ,CPSII
                                *,SNPSR
* STOT
                                                                                                                                                                                                                                          ORBIT
ORBIT
CHECK
CHECK
CHECK
ARCDAT
ARCDAT
* SINDMU
                C
                                 REAL MAG
LOGICAL RECYCL
EXTERNAL NUCASE, EXIT
COMMON/ARCDAT/
                             ARCDAT
ARCDAT
                                                                                                                                                                                                                                          ARCDAT
                                                                                                                                                                                                                                          ARCDAT
ARCDAT
ARCDAT
                                                                                                                                                                                                                                          ARCDAT
                                                                                                                                                                                                                                         ARCDAT
ARCDAT
MAP
CMTRL
CMTRL
CMTRL
CMTRL
CMTRL
                                                                                                                                                                                                                                          CHTRL
                                                                                                                                                                                                                                         JUL21
D
                                COMMON /PC/
PC1 N PC3
COMMON/GLOBAL/
                                                                                         , I DP
                                                                                                              ,PC5
                                                                                                                                                                                                                                          GLOBAL
                              GLOBAL
GLOBAL
GLOBAL
74.
75.
                                                                                                                                                                                                                                         GLOBAL
```

```
CDMMON /BLOCK/ JIC(10, 20), JICT(10, 20), JTC(10, 20), JTAB(20),
*ITCT(10, 20), LAB(20), NOKNOW, NOC(20), VALIC(16, 20),
*VALIC(10, 20), JPAY

DIMENSION TABLE(1), TEMP(25), TEMP(50), NU(1)

EQUIVALENCE (JTABLE, TABLE)

DATA RAD/57.29571951308237'

DATA CHECKX /6H CHECK/

4 FORMAT(1H1, 29HMAXIMUM NUMBER OF ITERATIONS=, 13, 13X, 17HDESIRED
CHECK
*ACCURACY=, E13.6)
6 FORMAT(1H, 26HADAMS-MOULTON INNER LOOPS=, 12)
10 FORMAT(1H, 23X, 27H****BDUNDARY CONDITIONS****)
11 FORMAT(1H, 10HSUBARC NO., 13/1HO, 2X, 7HPERTURB, 11X, 15HTO MATCH CHECK
*BOUND-/1H', 12HVARIABLE'NO., 7X, 17HARY CONDITION NO., 7X, 12HTO
*THE VALUE, 7X, 12HAT THE POINT/)
12 FORMAT(1H, 5X, 12, 11X, 18, 14X, E13.6, 11X, 13-)
13 FORMAT(1HO, 45HTOTAL NUMBER OF BOUNDARY CONDITIONS TO MATCH=, 13)
CHECK
               76.
77.
78.
79.
81.
823.
84.
85.
86.
              889
90...
91...
93...
94...
97...
98...
                                                                                                                                                                                                                                                                                                                                                                 CHECK
CHECK
CHECK
CHECK
                                                              ZERO OUT CONTROL BLOCK.
                                                           INITIALIZE REF. LATITUDE AND LONGITUDE QUANTITIES.
YMXRF = YMURF/RAD
SNXLMR = SIN(XLAMRF/RAD)
CSXLMR = COS(XLAMRF/RAD)
CSPSR = SIN(PSIRF/RAD)
LERR = 0
                                           DO 101 I = 1, 51
101 NU(I) = 0
           100.
101.
102.
103.
                                                                                                                                                                                                                                                                                                                                                                 CHECK
CHECK
CHECK
                                ε
                                                                                                                                                                                                                                                                                                                                                                 CHECK
CHECK
CHECK
CHECK
           106.
107.
108.
109.
110.
                                                             GET THE START TIME FOR THE CASE.
                                                             CALL SECOND(TRSTR)
                                                                                                                                                                                                                                                                                                                                                                CHECK
CHECK
CHECK
CHECK
CHECK
CHECK
         112.
113.
114.
115.
116.
117.
118.
119.
120.
121.
122.
123.
124.
125.
126.
127.
                                                              CHECK AND PRINT MAXIMUM NUMBER OF ITERATIONS AND DESIRED ACCURACY.
                                                             IF(ITRMAX .LT. 1) ITRMAX = 10
IF(ITRMAX .GT. 25) ITRMAX = 25
IF(EPSLON .LT. 1.E-8) EPSLON = 5.E-2
WRITE(6, 4) ITRMAX, EPSLON
                                                                                                                                                                                                                                                                                                                                                                 CHECK
                                                             CHECK AND PRINT NUMBER OF ADAMS-MOULTON INNER LOOPS.
                                                                                                                                                                                                                                                                                                                                                                 CHECK
                                                                                                                                                                                                                                                                                                                                                                 CHECK
                                                             IF(INNER .LT. 1) INNER = 1
IF(INNER .GT. 5) INNER = 5
WRITE(6, 6) INNER
                                                                                                                                                                                                                                                                                                                                                                 CHECK
                                    CHECK AND PRINT BOOM

WRITE(6, 10)

CALL BCOMD

WRITE(6, 14)

14 FORMAT(1M, 2016)

DO 102 I = 1, 9

102 WRITE(6, 15) (IIC(1, J), J = 1, NARC)

WRITE(6, 16)

16 FORMAT(1M, 26HCOSTATE INITIAL CONDITIONS/)

DO 103 I = 1, 9

103 WRITE(6, 15) (IICT(1, J), J = 1, NARC)

WRITE(6, 17)

17 FORMAT(1H0, 23HSTATE TARGET CONDITIONS/)

DO 104 I = 1, 9

104 WRITE(6, 15) (ITC(I, J), J = 1, NARC)

WRITE(6, 18)

18 FORMAT(1H0, 25HCOSTATE TARGET CONDITIONS/)

DO 105 I = 1, 9

105 WRITE(6, 15) (ITCT(1, J), J = 1, NARC)

COMPUTE MAGNITUDE OF DESIRED END CONDITION VECTOR

MAGBY = 0

PAGBY = 0
                                                             CHECK AND PRINT BOUNDARY CONDITIONS.
                                                                                                                                                                                                                                                                                                                                                                 CHECK
139.
130.
131.
132.
1334.
135.
136.
                                                                                                                                                                                                                                                                                                                                                                 CHECK
                                                                                                                                                                                                                                                                                                                                                               CHECK
        138.
139.
140.
141.
                                                                                                                                                                                                                                                                                                                                                               CHECK
CHECK
CHECK
        141.
142.
143.
144.
145.
146.
147.
148.
149.
                                                                                                                                                                                                                                                                                                                                                              CHECK
CHECK
CHECK
CHECK
CHECK
CHECK
CHECK
q
                                                           MAGBY = 0

DO 202 IARC = 1, NARC

II = JTAB(IARC)

IF(II .LE. 0) 60 TO 202
                                                                                                                                                                                                                                                                                                                                                                                              202-
```

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FORTRAM SYMBOL	MATH Symbol	CODE	DESCRIPTION	STORA	GE LOC	SUBA CODE	USAGE
			and the second s				
ARCDA	S _{ref}	t	Aeradynamic reference area (FT ²)	/ARCDAT/(1)	ARCIN I SWDRY I CHECK I FETCH I SALVE I STATEF I WT APUP I	SREF ARCDA ARCDA ARCDA SREF SREF ARCDA
CSPSR	cos(≠ _F)	0	Cosine of reference azimuth	/ORBIT /(153)	CHECK 0	CSPSR CSPSR
CSXLMR	cas(ρ-ρ _r)	0	Cosine of refernece latitude	/ORBIT /(197)	EMECK 0 PDBCOL I	CS XLMF
DELT		0	A twenty word array containing the quasitime compute interval for each subarc.		211)	ERROR I	DELT DELT DELT
EP\$LOW	€	•	OL iteration convergence criterian.	/GLOBAL/(8)	CHECK M SROPE I	EPSLON Epslon
ERR		0	Convergence criterion of iteration for the c's.	/0 /(8)	EMECK D MEMCS I	ERR Err
IARC		٩	Subarc number.	/CNTRL /C	24)	MARCH I BOOM MARANPT I CAPECK M COSTAB I COSTAB I COSTAB I TAMPACE M I MARCH I MARCH I SALVE M MARCH I SALVE M MARCH I SALVE M MARCH M M MARCH M M MARCH M MARCH M M M M M M M M M M M M M M M M M M M	I ARC I ARC
110		ī	A 10x20 array containing the initial condition codes for the QL state vector. The columns correspond to subarc starting points, the roos, to QL state variables.	/BLOCK /(1)	BEDND M BRANPT I CHECK I COSTAB I COSTAB I COSTAB I COSTAB I STAPPT I SALVE I	11C 11C 11C 11C 11C 11C 11C
1107		I	A 10x20 array containing the target condition codes for the state vector. The columns correspond to the subarc end points. The monzero entries in a column are the state target condition codes that apply at the end of the corresponding subarc.	/BLOCK /(261)	CHECK I COSTAB M COSTAI M COSTAO O MAGIC O SALVE I	IICT IICT IICT IICT IICT IICT
INARK		G	Logical unit on which initial and converged arcs are stored. IMARK = 11.	/GLOBAL/(95)	EMECK 0 FETCH 1 I WARC 1 MARCH 1 WRAPUP 1	IMARK IMARK IMARK IMARK IMARK
INBORY		0	Not used.	/CHTRL /(36)	CHECK 0	INBORY
INNER		M	Number of Adams-Moulton inner loops.	/GLOBAL/(9)	CHECK M	INNER INNER
110		ī	A 10x20 array containing the initial condition codes for the QL costate vector. The columns correspond to subarc starting points, the rows, to QL costate variables.	/BLOCK_/(461)	BRAMPT I BRAMPT I CHECK I COSTAB I COSTAI I ENDPT I	1TC 1TC 1TC 1TC 1TC 1TC

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.



SYMBOL	MATH SYMBOL	CODE DESCRIPTION	STORAGE BLOCK LO	C SUBRICODE VAR
17CT		I A 10x20 array containing the QL costate analog the array IICT. The columns correspond to suba end points. The nonzero entries in a column ar the numbers of those components of the vector O Equation 16.6-34 of Volume I of the PADS docume that contain the value of a costate target condition that applies at the end of the corresponding subarc.	rc e in	21) 8COMO O ITCT 8RAMPT I ITCT CMECK I ITCT COSTAB O ITCT COSTAB O ITCT INTRPT I ITCT MAGIC O ITCT
ITRMAX		M Maximum number of QL iterations.	/GLOBAL/(1	10) CHECK M ITRMAX GROPE I ITRMAX
JTAB		1 An array containing the number of monzero entri in each column of the array IICT.	es /BLOCK /(60	DI) BCOMD M JTAB BRAMPT J JTAB CMCCK I JTAB CMCK J JTAB COSTAB I JTAB COSTAB I JTAB EMOPT I JTAB INTRPT I JTAB MAGIC I JTAB
KARD		M The total number of homogeneous solutions eventually to be integrated.	/CNTRL /(1	10) CHECK # KARD
KPAGE		D Not used.	/CNTRL /(2	21) CHECK O KPAGE GROPE O KPAGE
LINES	•	D Not used.	/CNTRL /(7) CHECK O LINES
MAGBY		M The magnitude of all of the desired values of to state target conditions.	he /D /(7) CHECK M MAGBY MEMCS I MAGBY
MAP		D An array that maps the initial arc state and costate into the QL state and costate.	/MAP /(1) CHECK D MAP INARC I MAP
MINES		0 Not used.	/CNTRL /(2	20) CHECK O MIMES
N		I Total number of QL state and costate variables. = 18.	N /PC /(2) BNDRY I N CHECK I N IMMRC I N LIMDRY I N NLDRY I N NUDRWAL I N RKUTTI I N SALVE I N WRAPUP I N
NARC	N ₃	I Number of suborcs in the problem.	/GLOBAL/(1	B BCOND I MARC BMDRY I MARC CMECK I MARC EMOPT I MARC EMOPTO I MARC EMYPRO I MARC I MARC I MARC I MARC MAGIC I MARC OLTOSZ I MARC MARC MARC MARC MARC MARC MARC MARC
NNP	٩	M Number of QL state and costate variables.(18)	/CNTRL /(2	22) CHECK M NNP INTERP I NNP
NOKNOW		I The total number of free (unknown) state and costate variables over all the subarcs.	/BLOCK /(84	RI) CMECK I NOKNOW COMOMO I NOKNOW COSTAB M NOKNOW COSTAI M NOKNOW COSTAO M NOKNOW GROPE I NOKNOW MAGIC I NOKNOW
WU		O The largest number of quantities requiring numerical integration per QL iteration.	/CNTRL /(1) CHECK B NU
N UP		O Same as NU.	/CNTRL /(2	23) CHECK 0 NUP GROPE. I NUP INARC I NUP
PSIRF	ı	I Reference szimuth.	DEG) /GLOBAL/(6	8) CHECK I PSIRF

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FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STOR BLOCK	LOC	<u>Subrou</u> Subr		USAGE
RHOC		Đ	The magnitude of the error in the current QL iteration.	/CNTRL /	17)	CHECK GROPE	0	RHOC RHOC
RHOP		0	The magnitude of the error in the preceding QL iteration.	/CNTRL /	16)	CHECK GROPE	0	RHOP RHOP
SNPSR	sin(\psi_r)	0	Sine of reference azimuth	/ORBIT /	152)	CHECK PDBCQL	0	SNPSR SNPSR
SNXLMR	$sin(\rho-\rho_{_{\rm F}})$	0	Sine of reference latitude	/ORBIT /	146)	CHECK	0	SNXLAR SNXLAR
TRSTR		1	Not used.	/CNTRL /	25)	CHECK ET1ME	I	TRSTR TRSTR
VALTC		ı	A 10x20 array containing the desired values of the state target conditions whose codes appear in the array IICT.	· /BLOCK /	1062)	BCOND BRANPT CHECK ENDPT INTRPT	1	VALTC VALTC VALTC VALTC VALTC
XLAMRF	Pr	1	Reference letitude. (DEG	i) /GLOBAL/	4)	CHECK	i	XLAMRF
YMURF	$\mu_{\mathbf{r}}$	1	Reference longitude. (DEG) /GLOBAL/	5)	CHECK	i	YMURF
YMXRF	Pr	0	Reference longitude (RAD) /ORBIT /	145)	CHECK PDBCGL	0	YMXRF YMXRF

SUBRØUTINE CØHØMØ

Purpose

COHOMO calls in the solution for the c's.

```
COHOMO
COHOMO
COHOMO
COHOMO
CONTRL
CMTRL
CMTRL
CNTRL
CNTRL
COTOMO
BLOCK
BLOCK
BLOCK
BLOCK
COHOMO
COH
                                                                                                                                                                          PROGRAM COHOMO
THIS ROUTINE CALLS IN THE SOLUTION FOR THE C+S.
                                                                            Ç
```

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FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	•	STORA BLOCK	GE LOC	SUBROUT SUBR (USAGE VAR
KONVÉR			gical flag that indicates to the QL module that e QL iteration is converged.		/CNTRL /(28)	ALGCON APPLY ARCIN COHOMO GROPE NLDRY OUTPUT RKUTT1	I 1 0 0 0 1 1 1 1 1 1	KONVER KONVER KONVER KONVER KONVER KONVER KONVER
NOK NOW			e total number of free (unknown) state and state variables over all the subarcs.		/BLOCK /(841)	CHECK COHOMO COSTAB COSTAI COSTAO GROPE MAGIC	1 (A	HOKNOW HOKNOW HOKNOW HOKNOW HOKNOW HOKNOW

SUBRØUT I NE CØNTRL

Purpose

CONTRL controls the calculation of the control vector

CONTRL

```
CONTRL
CONTRL
CONTRL
CONTRL
ARCDAT
                                                                                                                            SUBROUTINE CONTRL
   1.
2.
3.
4.
5.
6.
7.
8.
9.
                                                           CCC
                                                                                                                                                                                                                                                                              THIS ROUTINE TAKES CARE OF THE CONTROL CALCULATION
                                                                                                                            COMMON/ARCDAT/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
                                                                                                    *SREF
*IATM
*XLMAX
*MAEB
                                                                                                                                                                                                                                     ,EJ
,1MODE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DTNC
QMAX
PHMAX
MAEF
MUDA
ZE
REMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            , DTPI
, GMAX
, MAEA
, MAEG
, MWDB
, XT
, FRATE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                JPRO
ALFMAX
MAEE
,MZCG
                                                                                                                                                                                                                                                                                                                                                          JAER
GMDOT
MAED
MXCG
   11.
12.
13.
14.
15.
16.
17.
18.
19.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    BYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DYNA
JUL21
DYNA
   24.
25.
26.
27.
28.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DYNA
DYNA
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DYNA
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DYNA
DYNA
DYNA
DYNA
DYNA
DYNA
DYNA
DYNA
   33.
34.
35.
   36.
37.
       40.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DYNA
DYNA
DYNA
DYNA
DYNA
DYNA
DYNA
                                                                                                          COMMON /OYNA/
*MIT JI J2
*ILOAD FRM FKMM SWITCH INGF CL CLA CLM CLAA
*CLMM CLAM CD CDA CDM CDAA CDMM CDAA CDMM CDAA
*CLMM CLAM CD CDA CDM CDAA CDMM CDAA CDMM CDAA
*CVN199 DVN200 XMCGV XMCGW XMCGM XMCGW XM
   43.
44.
45.
 48.
49.
50.
51.
52.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  JUL 21
AUG 09
D
                                                                                                            COMMON /D/
                                                                                                    ** LHT COMMON /D/
** H, X1(4), MAGBY, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI, *ALT, ** ALT, ** AL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    JUL21
```

*XKIMD , XK2MD , XK3MD , XK1MA , XK2MA , XK3MA , XK1ZT , XK2ZT , XK3ZT ,

```
XK3VV
XK3RV
XK3RV
                                                                                                                                                                                              MATS
MATS
MATS
    76.
77.
78.
79.
80.
81.
                                                                                                                                                                                              , XK3UP
, XK3RR
, XK3UO
, XK3UU
, XK3UU
, XK3MM
    83.
84.
85.
   88.
89.
91.
92.
93.
95.
96.
97.
                           MATS-
MATS-
MATS
MATS
MATS
MATS
CONTRL
              Ċ
                                                               INITIALIZE PASS FLAG
                             IPASS = 0
                             IPASS = 0

IS THIS ANY NONOPTIMAL CONTROL MODE OTHER THAN VERT.
RISE/PITCHOVER.

IF(IMODE .GT. 3) GO TO 103

NO. IS BANK ANGLE TO BE OPTIMIZED.

IF(IMODE .EQ. 1) GO TO 102

NO. IS THIS VERT. RISE/PITCHOVER

IF(IMODE .EQ. 3) GO TO 101

NO. OPTIMAL ANGLE OF ATTACK BUT BANK ANGLE ZERO.
  101.
                                                                                                                                                                                              CONTRL
 102.
103.
104.
105.
                                                                                                                                                                                              CONTRL
CONTRL
CONTRL
              C
               ¢
                                                                                                                                                                                              CONTRA
106.
107.
108.
109.
                                                                                                                                                                                              CONTRL
CONTRL
CONTRL
                                                                                                                                                                                                                 101-
               C
                             KODE = 2
60 TO 103
                                                                                                                                                                                              CONTRL
                                                                                                                                                                                                                                 103
110
                                                               COMPUTE BANK ANGLE FOR VERT. RISE/PITCHOVER
                                                                                                                                                                                              CONTRL
                   101 XKG = (V*=2/R - 6)*CDSGAM + DMEGA*CDSRHO+(2.*V*SINFSI + R*DMEGA

**(COSHO*COSGAM + SINRHO*COSFSI*SINGAM)) - V*GAMAAD

XKP = V*COSGAM*SINRHO*(V/(R*COSHO)*COSGAM*SINPSI + 2.*OMEGA)

* + OMEGA*COSRHO*(R*OMEGA*SINRHO*SINPSI - 2.*V*COSPSI*SINGAM)

DENOM = SQRT(XKG**2 + XKF**2)

SINPHI = SIGN(I. XKG)*XKP*DEMOM

COSPHI = ABS(XKG)/DEMOM

PHI = ATANZ(SINPHI, COSPHI)

GO TO 103
111.
112.
113.
114.
115.
                                                                                                                                                                                              CONTRL
                                                                                                                                                                                              CONTRL
                                                                                                                                                                                              CONTRL
CONTRL
CONTRL
                                                                                                                                                                                              CONTRL
                                                                                                                                                                                              CONTRL
                                                               COMPUTE OPTIMAL BANK ANGLE.
120
               C
                                                                                                                                                                                              CONTRI
                   COMPUTE OPTIMAL BANK ANGLE.

102 KODE = 1
CGLG = LGAM*COSGAM
DENOM2 = LPSI**2 + CGLG**2
DENOM = SQRT(DENOM2)
SINPHI = LPSI*0EMOM
IF(COSPHI*CGLG .LT. 0.) SINPHI = -SINPHI
COSPHI = SIGN(1., COSPHI)*ABS(CGLG)/DENOM
PHI = ATANZ(SINPHI, COSPHI)
PG = SINGAM*LPSI*LGAM*/DENOM2
PLG = -LPSI*COSGAM*/DEMOM2
PLP = CGLG/DENOM2
COMPUTE IN-PLANE CONTROL
121.
122.
123.
124.
125.
126.
                                                                                                                                                                                              CONTRL
                                                                                                                                                                                              CONTRL
                                                                                                                                                                                              CONTRL
                                                                                                                                                                                              CONTRL
                                                                                                                                                                                              CONTRL
 128.
129.
130.
                                                                                                                                                                                             CONTRL
CONTRL
CONTRL
132.
                                                              COMPUTE IN-PLANE CONTROL
                    103 CALL NPLANE
133.
                                                                                                                                                                                             CONTRL
                            IS THIS THE FIRST BANK ANGLE PASS.

IF(1PASS .NE. 0) GO TO 104

YES. MAY WE TRY THE SUPPLEMENT OF THE BANK ANGLE.

IF(1MODE .NE. 1 OR. NOT. ILOAD .OR. PHMAX .GT. 0.) GO TO 105

YES. 1S THIS THE LAST BANK ANGLE PASS.
134.
135.
136.
137.
            ε
                                                                                                                                                                                             CONTRL
CONTRL
CONTRL
            ε
                                                                                                                                                                                                                             105
138
                                                                                                                                                                                             CONTRL
139.
140.
141.
                    104 IF(IPASS .LE. 1) GO TO 106
YES. COMPUTE PARTIALS OF IN-PLANE CONTROL W/RESP.
TO STATE AND COSTATE.
                                                                                                                                                                                              CONTRL
                                                                                                                                                                                             CONTRL
CONTRL
                                                                                                                                                                                             CONTRL
CONTRL
CONTRL
CONTRL
142.
143.
144.
145.
146.
                    105 CALL ALGCNY(J1, J2, J3)
SET CONTROL FLAG IN CASE ALPHA IS SATISFYING AN IN-
EQUALITY CONSTRAINT AND RETURN
IF(IRODE .LE. 2 .AND. J3 .NE. 1) KODE = 1 + 2*KODE
              ç
                                                              COMPUTE NEG. SECOND PARTIAL OF HAMILTONIAN W/RESP. TO BANK ANGLE
```

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150. C 151. 152. C 153. 154. C 155.	06 YLTOT = (LGAM*COSPHI + LPSI*SINPHI/EOSGAM)*(T*SIDAE -DB*SINA+LIFT) TEST FOR MAXIMIZING MAMILTONIAM. IF(YLTOT .GE. 0.) GO TO 109 MINIMIZING. IS THIS THE FIRST PASS. IF(IPASS .NE. 0) GO TO 108 YES. MAKE THE NEXT PASS THE LAST. IPASS = 2 COMPUTE SUPPLEMENT OF BANK ANGLE	CONTRL CONTRL CONTRL CONTRL CONTRL CONTRL	109-	1087		
157. 1 158. 159. 160. 161. C 162. C 163. 164. 165. C	07 PHI = PHI + SIGN(1., SINPHI)+PI SINPHI = -SINPHI COSPHI = -COSPHI KODE = 1 IF THE PRECEEDING PASS BROUGHT ABOUT THROTTLING, TURN THROTTLING OFF - IF(SWITCH)- J1 = 2 GO TO 103 RESTORE SAVED QUANTITIES FROM PRECEEDING PASS	CONTRL CONTRL CONTRL CONTRL CONTRL CONTRL CONTRL CONTRL CONTRL CONTRL				1
166. 1 167. 168. 169. 170. 171. 172. 173. 174. 175. C	D8 T = TSAV DELTAE = DELSAV ALPHA = ALFSAV PHI = PHISAV SIMPHI = SIMSAV COSPHI = COSSAV J1 = J1S J3 = J3S G0 T0 105 COMPUTE HAMILTONIAN FOR THIS PASS	COMTRL COMTRL COMTRL COMTRL COMTRL COMTRL COMTRL CONTRL CONTRL CONTRL			105-	
177. C 178. 179. C 180. 181. 182. C 183. C	D9 HSTAR = V*LV*(T*CODAE - DB*COSA - DRAG) + YLTOT IS THIS THE FIRST PASS IF(IPASS .EG. 0) GO TO 110 WAS THIS PASS BETTER THAN THE LAST. IF(HSTAR .GT. HSTARS) GO TO 105 GO TO 108 SAVE NECESSARY QUANTITIES IN CASE THE NEXT PASS IS WORST THAN THIS PASS	CONTRL CONTRL CONTRL CONTRL CONTRL CONTRL CONTRL CONTRL	110-	108	105-	
185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195.	HSTARS = MSTAR TSAV = T DELSAV = DELTAE ALFSAV = ALPNA PMISAV = PNI SINSAV = SINPHI COSSAV = COSPHI	CONTRL	107—			

FORTRAM SYMBOL	MATH Symbol	CODE	DESCRIPTION		S1 BLDC	ORAL	LOC	SUBROUTING SUBR COL	E USAGE
ALPHA	α	M Angi	e of attack	(PAD)	/DYNA	/(79)	AEROCO I ALGCON M ALZ I ARCIN M CONTRL M ENVPRO I MOMECO I NOLACI I OUTPUT I TRAJIN O UT	ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA
CODAE	cos(α-δ _ε)	I See	syabol .		/DYNA	/(151)	AL1 I AL4 I AL6 I AL7 I AL8 I AL9 I APPLY I CONTRL I NLDRV I TH3 I UT 0	CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE
COSA	C 0 S &	I See	sy abo i		/DYNA	/(10)	ALI I AL4 I AL6 I AL7 I AL8 I AL9 I APPLY I CONTRL I MLDRY I OUTPUT I TH3 I UT M	COSA COSA COSA COSA COSA COSA COSA COSA
COSGAM	. cos7	1 See	symboli		/DŸNA	/(4)	AL1 I AL4 I AL7 I AL8 I AL9 I CONTRL I NLDRV I OUTPUT I OUTPUT I STATEF M	COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM
COSPHI	cos#	M See	symbol .		/DYNA	/(93)		COSPHI COSPHI COSPHI COSPHI COSPHI COSPHI
COSPS1	cos♥	I See	symbol .		/DYNA	/(AL4 I AL7 I AL8 I AL9 I CONTRL I NLDRY I PDBCQL I STATEF 0	COSPSI COSPSI COSPSI COSPSI COSPSI COSPSI COSPSI
COSRHO	c o s p	1 See	syabol .		/DYNA	/(AL4 I AL7 I AL8 I AL9 I CONTRL I NUDRY I OUTPUT I PDBCQL I STATEF M	COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO

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FORTRAN Symbol S	MATH Symbol	COD	E DESCRIPTION		BLOC	CRAG K	LOC	SUBROUT SUBR C	INE USAGE OBE VAR
DB	D _b	i	Base drag	(LBS)	/ DY NA	/(163)	AL4 AL6 AL7 ALB AL9 APPLY	f OB I DB I DB
 DELTAE	⁶ E	m	Engine deflection	(RADS)	/DYNA	/(155)	ALGCON PARCIN POUTPUT I TRAJIN CUT	DELTAE DELTAE DELTAE DELTAE DELTAE DELTAE DELTAE DELTAE
DRAG	D		Aerodynamic drag	(LBS)	/DYNA		69)	AL5 AL7 I AL8 I AL9 I APPLY I CONTRL I ENVPRQ I NLDRV I OUTPUT I UT	DRAG DRAG DRAG DRAG DRAG DRAG DRAG DRAG
6	g	1	Instantaneous gravitational acceleration	(FT/SEC ²)	/DYNA	/(8)	AL4 I AL7 I AL8 I AL9 I CONTRL I NLDRY I STATEF	6 6 6
GAMMAD		i	Pitch rate	(RAD/SEC)	/DYNA		88)	AL4 I ARCIN O CONTRL I NLDRV I	GAMMAD
ILOAD		I	Logical flag that is true if there is any aerodynamic load on the vehicle.		/DYNA	/(181)	ARCIN P CONTRL I NPLANE I UT I	ILOAD ILOAD
I MODE		1	Control mode option flag		/ AR CDA	T/(8)	ARCIN I CONTRL I NPLANE I	I MO O'E
11		۸	Thrust option flag. J1 = 1: Constant thrust; J1 = 2: Input vacuum thrust; J1 = 3: Powered total acceleration i J1 = 4: Air-breather engine.	ieit;	/DYNA	/(APPLY I ARCIN O CONTRL M FORCES I APLANE I STATEF I THROTL M) 11 11 11 11
J2		1	Engine deflection option flag. J2 = 1: Constant engine deflection; J2 = 2: Moment balancing.		/DYNA	/(174)	ARCIN D CONTRL I NPLAME I	75 75
13		M	Angle of attack option flag. J3 = 1: Optimal angle of attack; J3 = 2: Constant angle of attack; J3 = 3: Untrimmed lift limit; J3 = 4: Vertical rise or pitchover; J3 = 5: Unpowered total acceleration J3 = 6: Gravity turn; J3 = 7: Dynamic pressure constraint; J3 = 8: Heating rate constraint; J3 = 9: Reynolds number constraint.		/DYNA	/(ARCIN O CONTRL M NPLANE M OUTPUT I	13 13

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		BLOCK	ORAG K	LOC	SUBROU SUBR	TINE	USAGE
KODE		KODE :	rector flag = 0: Free fail, $\alpha = \theta = 0$; = 1: Both α and θ optimal; = 2: α optimal and $\theta = 0$; = 3: α nonoptimal and θ optimal; = 4: Vertical rise or pitcho 5: α nonoptimal and $\theta = 0$.	ver;	/DYNA		25)	APPLY ARCIN CONTRL FORCES NLDRY STATEF	0 H	KODE KODE KODE KODE
LGAM	λ,		light path angle costate		/D	/(101)	ALI ARCIN CONTRL NLDRY DUTPUT WRAPUP	I	LGAM LGAM LGAM LGAM LGAM LGAM
LIFT	L	1 Aerodynamia	z 11 11	· (LB5)	/ DY NA	/(60)	AL4 AL5 AL6 APPLY CONTRL ENYPRO OUTPUT TH3 UT		L) FT L) FT L) FT L) FT L) FT L) FT L) FT L) FT
LPSI	λ.,	I Relative as	zimuth angle costate		/0	/(102)	AL1 ARCIN CONTRL NLDRY OUTPUT WRAPUP	I 1 I I I I I I I I I I I I I I I I I I	LPSI LPSI LPSI LPSI LPSI LPSI
LV	λ,	I Rejative ve	elocity costate		/D	/(100)	AL1 CONTRL NLDRY GUTPUT WRAPUP	I L	LV LV LV
OMEGA	•	I Earth rotat	tion rate	(RAD/SEC)	/DYNA	/(5)	AL4 AL7 CONTRL PDBCQL TRAJIN	I 0 I 0 I 0	DMEGA DMEGA DMEGA DMEGA DMEGA
PG	٠,	O See symbol			/MATS	/(551)	AL4 APPLY ARCIN CONTRL	1 P	P6 P6 P6
PHI	•	A Bank angle		(RAD)	/DYNA	/(80)	CONTRL OUTPUT WRAPUP	R P	PH1 PH1 PH1
PHMAX		I Belly down	flag		/ARCDA	T/(17)	CONTRL	1 P	KARH
PLG	ϕ_{λ_p}	O See symbol	•		/MATS	/(APPLY	I P	578 578 578
PLP	****	D See symbol			/MATS	11	571)		1 P	LP LP LP
R	R	l Radial dist	tance from earth center to vo	ehicle (FT)	/DYNA			AL4 AL7 AL8 AL9 CONTRL ENVPRO NLORV PDBCQL QLTOSZ STATEF	I R I R I R	

FORTRAM Symbol	MATH Symbol	CODE	DESCRIPTION	ST BLOCK	ORAGE LOC	SUBROUTINE USAG SUBR CODE VAR
SIDAE	sin(α-6 _E)	I See symbol		/DYNA	/(152	AL1 I SIDAE AL4 I SIDAE AL6 I SIDAE AL7 I SIDAE AL8 I SIDAE AL9 I SIDAE AL9 I SIDAE CONTRL I SIDAE TH3 I SIDAE TH3 I SIDAE UT O SIDAE
SINA	s i n a	I Sea symbol		/DYNA	/(9	O AL1
SINGAM	sin?	l See symbol		/DYNA	/(3	AL1
SINPHI	sìn∲	A See symbol		/DYNA	/(92	AL1 I SINPH AL4 I SINPH APPLY I SINPH CONTRL M SINPH OUTPUT I SINPH
SIMPSI	sinv∕	1 See symbol		/ DY NA	/(94	AL4 I SINPS AL7 I SINPS AL8 I SINPS AL9 I SINPS CONTRL I SINPS MLDRY I SINPS PDBCQL I SINPS STATEF O SINPS
5 I MR H ()	s i n p	1 See symbol		/DYNA	/(96	AL9 I SINRHI AL7 I SINRHI AL8 I SINRHI AL9 I SINRHI CONTRL I SINRHI OUTPUT I SINRHI PDBCQL I SINRHI STATEF M SINRHI
SWITCH			that is true if this is the compute the powered acceleration constraint	/DYNA	/(184)	CONTRL I SWITCH NPLANE I SWITCH THROTE O SWITCH

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOCK	RAGE LOC	SUBROUTINE USAGE SUBR CODE VAR
T	T	M Th	rust (LBS)	/DYNA	/(42)	ALGCON M T AL1 1 T AL4 I T AL6 I T AL7 I T AL8 I T AL9 I T APPLY I T TH1 I T TH2 I T TH3 I T TH4 I T
٧	·	1 R.	istive velocity. (FT/SEC)	/D	/(91)	AL1 I V AL4 I V AL4 I V AL8 I V AL8 I V AL9 I V BCOND I NOM BRANPT M NOM CONTRL I V ENUPRO I V FETCH O MOM INTERP M V INTERP M V NLDRV I V ONDRV I V POBCOL I V STATEF I V WRAPUP I V
XKG	k,	M Al.	gebraic equation used in vertical rise and	/DYNA	/(101)	AL4 I XKG
XKP	k _ø		gebraic equation used in vertical rise and tchover	/DYNA	/(102)	AL4 1 XKP CONTRL M XKP

SUBRØUT I NE CØSTAB



Purpose

COSTAB determines the costate initial and target conditions at a branch point.*

^{*}See Sections 16.6, 17.1 and 17.2 in Vol. I.

```
COSTAB
COSTAB
COSTAB
COSTAB
GLOBAL
GLOBAL
GLOBAL
                                           SUBROUTINE COSTAB
        12345678901123456789112345678
                                                                                      THIS ROUTINE DETERMINES THE COSTATE INITIAL AND TARGET CONDITIONS FOR A BRANCH POINT.
                                        GLOBAL
                                                                                                                                                                                                                                                   GLOBAL
D
                            **LMT
COMMON /D/
*X, H, XI(4), MAGBY, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI,
*ALT, AND MU, M, TAU, HT LV, LGAM, LPSI, LR, LRND, LAU, LM, LTAU,
*LHT, D109, D10, BV(40), 2SAVE(20), BT(20), NPDINT(20), DELT(20)

DIMENSION NOM(20)
EQUIVALENCE (NOM, V)
COMMON /CNTRL/
*NU
**ITER** ITAPA , ITAPB , JMIN , JMAX , LINES , KPT , MOM ,
*KARD , INDX(4) , NEWNOM, CNTO16, RHOC , RHOP , NPTS , MINES ,
*KPAGE , NNP , NUP , LARC , TRSTR , HAX , ZLAST , KODES
LOGICAL INBORY, NEWNOM, KONVER, NOPHNT , NUPAGE , COMMON , MOVARY , PLAST , ZLAST , KODES
LOGICAL INBORY, NEWNOM, KONVER, NOPHNT , NUPAGE , COMMON , MOCKY , DO , ITC(10, 20) , LTAB(20), *VALTC(10, 20) , LTAB(20), NOKNOW, NOC(20), VALTC(10, 20) , JTAB(20),
*VALTC(10, 20) , LTAB(20), NOKNOW, NOC(20), VALTC(10, 20) , JTAB(20),
*VALTC(10, 20) , LPAY
DIMENSION AB(27, 27), SPART(9), MAP(10)
DATA MAP /8 , 12, 4, 7, 3, 5, 6, 0, 9/, CUSTAB/6HCOSTAB/
DO 101 J = 1, 27

101 ABI, J) = 0
NATC = NFARC + 1
SET UP THOSE ROWS OF THE AB MATRIX THAT RESULT FROM THE INITIAL CONDS. ON THE STATE.

DO 113 I = 1, 9
FIRST ARC OF FIRST BRANCH
                                         COMMON /D/
                                                                                                                                                                                                                                                     JUL21
                                                                                                                                                                                                                                                  D
CNTRL
CNTRL
CNTRL
CNTRL
CNTRL
BLOCK
BLOCK
BLOCK
BLOCK
BLOCK
BLOCK
                                                                                                                                                                                                                                                   COSTAB
COSTAB
COSTAB
COSTAB
COSTAB
0
         31.
32.
33.
34.
35.
36.
37.
38.
40.
                     Ç
                                                                                                                                                                                                                                                   COSTAB
                                                                                                                                                                                                                                                   COSTAB
                                          DO 113 I = 1, 9
FIRST ARC OF FIRST BRANCH
                      C
                                                                                                                                                                                                                                                   COSTAB
                                          IF(IIC(I, IARC) - 1) 102, 103, 104
CONTINUOUS STATE
                                                                                                                                                                                                                                                   FATZON
                                                                                                                                                                                                                                                                         102 - 103 - 104
                                                                                                                                                                                                                                                   COSTAB
                               102 MA = MA + 1
         42.
                                                                                                                                                                                                                                                   COSTAB
                                          AB(MA, I + 9) = 1
AB(MA, I + 18) = -1
GO TO 107
         43.
44.
45.
46.
                                                                                                                                                                                                                                                   COSTAB
COSTAB
                                                                                                                                                                                                                                                                                                                        107
                                                                                                                                                                                                                                                   COSTAB
COSTAB
                                                                                  KNOWN STATE
                             103 MA = MA + 1
AB(MA, 1 + 9) = 1
GO TO 107
                                                                                                                                                                                                                                                  COSTAB
COSTAB
COSTAB
         47.
         48.
                                                                                                                                                                                                                                                                                                                         107
        50.
51.
                             104 IF(IIC(I, IARC) - 5) 107, 105, 106
KNOWN DROP WEIGHT
                                                                                                                                                                                                                                                  COSTAB
COSTAB
                                                                                                                                                                                                                                                                         105
                                                                                                                                                                                                                                                                                        ADI
                                                                                                                                                                                                                                                                                                        . 1 6 2
        52.
53.
54.
55.
56.
                             105 MA = MA + 1

AB(MA, I + 9) = -1

AB(MA, I + 18) = 1

GO TO 107
                                                                                                                                                                                                                                                  COSTAB
                                                                                                                                                                                                                                                  COSTAB
COSTAB
COSTAB
                                                                                                                                                                                                                                                                                                          107
                           106 MA = MA + 1

CALL FETCH(-NBRAM)

MPRO = GR*(ZSAVE(7) - M)

CALL MIDRP(MPRO, MDRP, DMDRP, 3)

AB(MA, I + 9) = -1

AB(MA, I + 18) = 1. - DMDRP

FIRST ARC OF SECOND BRANCH
                       C
                                                                                                                                                                                                                                                   COSTAB
        57.
58.
59.
60.
61.
62.
                                                                                                                                                                                                                                                  COSTAB
COSTAB
COSTAB
                                                                                                                                                                                                                                                  COSTAB
COSTAB
COSTAB
                       C
                                                                                                                                                                                                                                                  COSTAB
                       107 IF(11C(1, LARC) - 1) 108, 109, 110 .
C CONTINUOUS STATE
        64.
65.
                                                                                                                                                                                                                                                  COSTAB
                                                                                                                                                                                                                                                                                       7109
                             108 MA = MA + 1

AB(MA, I) = 1

AB(MA, I + 18) = -1

60 TO 113
        66.
67.
68.
                                                                                                                                                                                                                                                  COSTAB
COSTAB
COSTAB
                                                                                                                                                                                                                                                                                                                       113-
                                                                                                                                                                                                                                                  COSTAB
                                                                                   KNOWN STATE
                            109 MA = MA + 1
                                                                                                                                                                                                                                                  COSTAB
```

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72. 73.	AB(MA, I) = 1 GO TO 113	COSTAB COSTAB	11:
74. 11 75. C	0 IF(I)C(I, LARC) - 5) 113, 111, 112 Known drop weight	COSTAB COSTAB	111-112-113-
76. 11 77. 78. 79.	1 MA = MA + 1 AB(MA, I) = -1 AB(MA, I + 18) = 1 GO TO 113	COSTAB COSTAB COSTAB COSTAB	113
 	2 MA = MA + 1 IF(IIC(I, IARC) .LT. 7) GO TO 1121 WEIGHT DISTRIBUTION FROM STEM TO BRANCHES	COSTAB COSTAB COSTAB	1121-7
83. 84. 85. 86.	AB(MA, I) = -1 AB(MA, I + 9) ≈ -1 AB(MA, I + 18) = 1 GO TO 113	COSTAB COSTAB COSTAB COSTAB	113
87. C 88. 112: 89.	SIZING DROP WEIGHT CALL FETCH(-NFARC) WPRO = GR*(ZSAYE(7) - M)	COSTAB COSTAB	
90. 91. 92. 93. 11	CALL MTORP(MPRO, MDRP, DWDRP, 3) AB(MA, I) = -1 AB(MA, I + 18) = 1 DWDRP 3 CONTINUE	COSTAB COSTAB COSTAB	-
94. C 95. 96. C 97.	STORE NUMBER OF STATE TARGET CONDS. AT END OF STEM MTARG = JTAB(NBRAN) ARE THERE ANY STATE TARGET CONDS. IF(MTARG. LE. 0) GO TO 117	COSTAB COSTAB COSTAB COSTAB	117
98. C 99. C 100. 101.	YES. ADD ROWS TO AB MATRIX THAT RESULT FROM THE TARGET CONDS. ON THE STATE. DO 116 I = 1, RTARG MA \approx RA + 1	COSTAB COSTAB COSTAB COSTAB	
103. 104. C 105. 106.	KODE = ITC(1, NBRAN) IF(KODE .GT. 11) GO TO 114 SIMPLE RELATIVE STATE MATCH KODE = MATCH ADIMA MODE) + 18	COSTAB COSTAB COSTAB COSTAB	11147
107. 108. C	ABLMA, KODE) = 1 GO TO 116 COMPLEX COND. ON THE STATES 1 15K1P = 0	COSTAB COSTAB	1167
110. 111. 112.	CALL FETCH(-NBRAM) CALL PDBCQL(KODE, DUMMY, SPART, RUNNY, 1, 15K1P) DO 115 L = 19, 27 AB(MA, L) = SPART(L - 18)	COSTAB COSTAB COSTAB COSTAB	
114. 116 115. C	CONTINUE ARE THERE ANY TRANSVERSALITY CONDS. AT ALL	COSTAB COSTAB	
116. 117 117. C 118.	IF(MA .GE. 27) GO TO 132 YES. COMPLETE AND INVERT AB MATRIX. CALL BASIS(AB, MA, 27) CALL GJRV(AB, 27, 1.E-12, IERR)	COSTAB COSTAB COSTAB COSTAB	132
120. C 121. 122. C	IF(lerr .ne. o) Call Error(custab -1, 1) Analyze transversality Conds.	COSTAB COSTAB COSTAB COSTAB	
1123. 1124. 1125. 1126. 118	L = AA + 1 DO 131 J = L, 27 DO 118 I = 1, 9 IF(ABS(AB(I, J)) .GT. 1.E-12) GO TO 123 IF(ABS(AB(I, J)) .GT. 1.E-12) GO TO 123	COSTAB COSTAB COSTAB COSTAB	123——
128. C 129. 130.	DO 119 I = 10 18 DIFF = ABS(AB(1, J) - AB(1 + 9, J))	COSTAB COSTAB COSTAB	121
132. 133. 134.	KK = 0 00 120 I = 10, 18 IF(ABS(AB(I, J)) .LE. 1.E-12) &0 TO 120	COSTAB COSTAB COSTAB COSTAB	120-
135. 136. 137.	KK = KK + 1' IF(KK .GT. 1) GD TO 130 11 = 1 - 9 CONTINUE	COSTAB COSTAB COSTAB	130-
139. C 140. 141.	CONTINUOUS COSTATE BETWEEN STEM AND 1ST BRANCH IICT(II, IARC) = 0 GO TO 131	COSTAB COSTAB COSTAB	1317
01-44	•	i	

142. 143. 144. 145. 146. 147. 148.	121	KK = 0 DO 122 I = 10, 27 IF(KK .EQ. O .AND. I .GT. 18) GO TO 130 IF(ABS(AB(I, J)) .LE. 1.E-12) GO TO 122 KK = KK + 1 IF(KK .GT. 1) GO TO 130 II = I - 9	COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB	130-	
149. 150. 151. 152. 153. 154.	С	CONTINUE KNOWN COSTATE AT START OF 1ST BRANCH IICT(II, IARC) = 1 GO TO 131 DO 124 I = 10, 18 IF(ABS(AB(I, J)) GT. 1.E-12) GO TO 130 IF(ABS(AB(I, J)) GT. 1.E-12) GO TO 130	COSTAB COSTAB COSTAB COSTAB COSTAB	130-	131
155. 156. 157. 158. 159. 160. 161. 162. 163.	č	DOES NOT INVOLVE 15T BRANCH DIFF = ABS(AB(I J) - AB(I + 18, J)) IF(DIFF .GT. 1.E-12) GO TO 127 KK = 0 DO 126 I = 1, 9 IF(ABS(AB(I, J)) .LE. 1.E-12) GO TO 126 KK = KK + 1	COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB	127	
164. 165. 166. 167. 168. 169.	С	IF(KK .GT. 1) GO TO 130 II = 1 CONTINUE CONTINUOUS COSTATE BETWEEN STEM AND 2ND BRANCH IICT(II, LARC) = 0 GO TO 131 KK = 0	COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB	130-	131-
171. 172. 173. 174. 175. 176.		00 129 I = 1, 27 IF(KK .EQ. O'.AMD. I .GT. 9) 60 TO 130 IF(ABS(ABCI, J)) .LE. 1.E-12) GO TO 128 KK = KK + 1 IF(KK .GT. 1) GO TO 130 II = 1	COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB	130	
177. 178. 179. 180. 181. 182. 183.	128 129 C	IF(1 .EQ. 9) I = 18 CONTINUE KNOWN COSTATE AT START OF SECOND BRANCH IICT(II, LARC) = 1 GO TO 131 IF THIS IS A LTAU MATCH AND TAU FOR THE LAST ARC OF THE STEM WAS KNOWN PASS THIS TRANS. COND. UP AS TRIVIAL	COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB		131
185. 186. 187. 188. 199. 190. 191. 192. 193. 194.		IF(J .EQ. 26 .AND. IIC(8, NBRAN) .EQ. 1) GO TO 131 DO 1301 I = 1 9 DIFF = ABS(ABI, J) - AB(I + 9, J)) IF(DIFF .GT. 1.E-12) GO TO 1303 DIFF = ABS(ABI, J) - AB(I + 18, J)) IF(DIFF .GT. 1.E-12) GO TO 1303 KK = 0 DO 1302 I = 1, 9 IF(ABS(AB(I, J))).LE. 1.E-12) GO TO 1302 KK = KK = KK + 1	COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB	1303	
195. 196. 197. 198. 199. 200. 201. 202.	1302 C	IF(KK .GT. 1) GO TO 1303 I1 = I CONTINUE COSTATE DISTRIBUTION ACROSS BRANCH PT IICT(II LARC) = 7 GO TO 131 ANOTHER NON-TRIVIAL TRANS COND. STORE THE SHIFTED COL. NO. AS A POINTER TO THE COSTATE TARGET COND.	COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB COSTAB	1303-	131
203 204 205	131	NNTTC = NNTTC + 1 ITCT(NNTTC, NBRAN) = J - MA CONTINUE CONTINUE	COSTAB COSTAB	4	
206. 207. 208. 209. 210. 211.	132 C C	STORE THE NUMBER OF COSTATE TARGETS TO BE SATISFIED AT THE BRANCH POINT. LTAB(NBRAN) = NNTTC	COSTAB COSTAB COSTAB COSTAB COSTAB	•	

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COSTAB
COSTAB
COSTAB
COSTAB
COSTAB
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COSTAB
COSTAB
COSTAB
```

FORTRAN	MATH	CODE	DESCRIPTION	STORA		SUBROUTINE USA
SYMBOL	SYMBOL		DESCRIPTION	BLOCK	LOC	SUBR CODE VA
SR	9,		Gravitational acceleration at surface of the earth (FT/SEC ²)	/GLOBAL/(1)	ALS J GR APPLY I GR BRANPT I GR COSTAB I GR COSTAB I GR INTRPT I GR OUTPUT I GR PDBCQL I GR QLTOSZ I GR SALVE I GR STATEF I GR
IARC	1	1	Subarc number.	/CMTRL /(24)	ARCIN I IARC BCOND M IARC BDNDRY M IARC BRANPT I IARC COSTAB I IARC COSTAB I IARC FORCES I IARC FORCES I IARC FORCES I IARC FORCES I IARC MARC M IARC MARCH IARC COLTOSZ I IARC SALVE M IARC SALVE M IARC WRAPUP M IARC
116.		1	A 10=20 array containing the initial condition codes for the QL state vector. The columns correspond to subart starting points, the roms, to QL state variables.	/BLOCK /(1)	BCOND M IIC BRAMPT I IIC CHECK I IIC COSTAB I IIC COSTAB I IIC COSTAO I IIC INTRPT I IIC SALVE I IIC
11CT		A	A 10x20 array containing the target condition codes for the state vector. The columns correspond to the subarc end points. The nonzero entries in a column are the state target condition codes that apply at the end of the corresponding subarc.	/BLOCK /(201)	CHECK I IICT COSTAB M IICT COSTAI M IICT COSTAO O IICT MAGIC O IICT SALVE I IICT
ITC		ſ	A 10x20 array containing the initial condition codes for the OL costate vector. The columns correspond to subarc starting points, the rows, to OL costate variables.	/BLOCK /(401)	BCOND 0 ITC BRANPT I ITC CHECK I ITC COSTAB I ITC COSTAB I ITC COSTAB I ITC ENDPT I ITC IMTRPT I ITC
ITCT		0	A 10x20 array containing the QL costate analog to the array IICT. The columns correspond to subarc end points. The nonzero entries in a column are the numbers of those components of the vector 8 in Equation 16.6-34 of Volume I of the PADS document that contain the value of a costate target condition that applies at the end of the corresponding subarc.	/BLOCK /(621)	BCOND 0 ITCT BRANPT I ITCT CHECK I ITCT COSTAB 0 ITCT COSTAB 0 ITCT COSTAI 0 ITCT INTRPT I ITCT MAGGIC 0 ITCT
BATL BATL		I	An array containing the number of nonzero entries in each column of the array IICT.	/BLOCK /(601)	BCOND M JTAB BRANPT I JTAB CHECK I JTAB COSTAB I JTAB COSTAI I JTAB ENDPT I JTAB NARPT I JTAB MAGIC I JTAB

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		STORAG BLOCK	E LOC	SUBROUTIN SUBR COD	
LTAB			ray containing the number of nonzero entrie ch column of the array ITCT.	: 5	/BLOCK /(821)	BCOND O BRANPT I COSTAB O COSTAI O INTRPT I MAGIC M	LTAB LTAB LTAB LTAB LTAB LTAB
н	•	I Mass	(6	i'S) /	/ D /(97)	AL4 I AL7 I AL8 I AL9 I APPLY I BRANPT I COSTAB I COSTAB I INTRPT I NUDRY I OUTPUT I SALVE I STATEF I WAPPUP I	*******
NBR AM	N ₁	proble	r of the last subarc on the stem of a brancies. If the problem is not a branch problem, uBRAN = 0.		'GLOBAL/(19)	BNDRY I BRANPT I COSTAB I ENVPRO I INTRPT I MAGIC I OLTOSZ I SALVE I	NBRAN NBRAN NBRAN NBRAN NBRAN NBRAN NBRAN
NFARC	N ₂		r of the last subarc on the first branch. I roblem is not a branch problem, then NFARC =		GLOBAL/(BCOND I BNDRY I BRANPT I COSTAB I ENVPRQ I INTRP I MAGIC I QLTOSZ I SALVE I	NF ARC NF ARC NF ARC NF ARC NF ARC NF ARC NF ARC NF ARC
MOC		of fre	ray containing a running total of the number se (unknomn) state and costate variables at tart of each subarc.		BLOCK /(BNDRY I BRANPT I COSTAB O COSTAI O COSTAO O INARC I INTRPT I SALVE I WRAPUP I	NOC NOC NOC NOC NOC NOC NOC
NO K ad u			tal number of free (unknown) state and se variables over all the subarcs.	,	BLOCK /(CHECK I COMOMO I COSTAB M COSTAI M COSTAO M GROPE I MAGIC I	NO KNOW NO KNOW NO KNOW NO KNOW NO KNOW NO KNOW NO KNOW
ZSAVE		initia	ity word array containing the values from the idea of the state and costate at the initial of the trajectory.		D /1		BCOND OBRANPT I COSTAB I COSTAI I INTRPT I PDBCQL I SALVE I	ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE



SUBRØUT I NE CØSTA I

COSTAI determines the costate initial and target conditions at an intermediate point. $\mbox{\ensuremath{^{\circ}}}$

^{*}See Sections 16.6, 17.1 and 17.2 in Vol. I.

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SUBROUTINE COSTAL
                                                                                                                                                                  COSTAI
COSTAI
COSTAI
COSTAI
                                                         THIS ROUTINE DETERMINES THE COSTATE INITIAL CONDITIONS ON THE LATE SIDE OF AN INTERMEDIATE POINT AND WHICH TRANSVERSALITY CONDITIONS, IF ANY, MUST BE SATISFIED ON THE EARLY SIDE.
                                                                                                                                                                  COSTAI
COSTAI
GLOBAL
                          GLOBAL
GLOBAL
GLOBAL
GLOBAL
                                                                                                                                                                  BLOCK
BLOCK
                                                                                                                                                                  CHTRL
                                                                                                                                                                  CNTRL
CNTRL
CNTRL
CNTRL
                          JUL21
                                                                                                                                                                 COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
                   NNTTC = 0

MA = 0

DO 101 I = 1, 18

DO 101 J = 1, 18

101 AI(I, J) = 0
       35.
                                                                                                                                                                 COSTAI
COSTAI
COSTAI
38.
39.
40.
41.
42.
43.
                                                                                                                                                                 COSTAI
COSTAI
COSTAI
                                                        SET UP THOSE ROWS OF THE AL MATRIX THAT RESULT FROM STATE INITIAL CONDITIONS
                            DO 107 1 = 1 9
IF(IIC(I, IARC) - 1) 102, 103, 104
CONTINUOUS STATE
                                                                                                                                                                               102-103-109
                                                                                                                                                                  COSTAI
                   CONT

102 MA = MA + 1

AI(MA, I) = 1

AI(MA, I + 9) = -1

60 TO 107
                                                                                                                                                                 COSTAI
COSTAI
COSTAI
COSTAI
       45.
      46.
47.
48.
49.
                                                                                                                                                                                                                107
                                                       KNOWN STATE
                                                                                                                                                                 COSTAI
                    103 MA = MA + 1
Al(MA, I) = 1
GO TO 107
      50.
51.
52.
                                                                                                                                                                 COSTAL
                                                                                                                                                                 COSTAI
                                                                                                                                                                                                                107-
      53.
54.
                   104 IF(IIC(I, IARC) - 5) 107, 105, 106
Fixed Drop Weight
                                                                                                                                                                COSTA1
COSTA1
                                                                                                                                                                                          1106
                  105 MA = MA + 1
AI(MA, I) = -1
AI(MA, I + 9) = 1
GO TO 107
      55.
                                                                                                                                                                COSTAL
     56.
57.
58.
59.
                                                                                                                                                                COSTAI
COSTAI
COSTAI
                                                                                                                                                                                                     107
                                                       SIZING DROP WEIGHT
                                                                                                                                                                 COSTAI
                   106 MA = MA + 1

CALL FETCH(-IARC + 1)

WPRD = GR*(ZSAVE(7) - M)

CALL WTDRP(WPRD, WDRP, DWDRP, 3)

AI(MA, 1) = -1

AI(MA, 1 + 9) = 1. - DWDRP
                                                                                                                                                                COSTAL
       60.
       61.
      62.
63.
64.
                                                                                                                                                                COSTAI
COSTAI
COSTAI
                                                                                                                                                                 COSTAL
                                                                                                                                                                COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
      66.
67.
68.
69.
70.
71.
                    107 CONTINUE
                           CONTINUE

STORE NUMBER OF STATE TARGETS

MTARG = JTAB(IARC - 1)

ARE THAN ANY STATE TARGETS AT THIS POINT

IF(MTARG .LE. 0) 60 TO 111

YES. ADD THOSE ROWS TO AI RESULTING FROM TARGETS.

DO 110 I = 1, MTARG
              C
               C
               C
```

```
MA = MA + 1

KODE = 1TC(1, IARC - 1)

IF(KODE .GT. 11) GO TO 108

SIMPLE RELATIVE STATE MATCH

KODE = MAP(KODE) + 9

AI(MA, KODE) = 1

GO TO 110 COMPLEX TARGET CONDITION ON
                                                                                                                                                                          COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
     74.
75.
76.
77.
78.
79.
80.
                                                                                                                                                                                           108-
                                                                                                                                                                                                      110-
                                                          COMPLEX TARGET CONDITION ON STATES
                    108 ISKIP = 0
CALL FETCH(-IARC + 1)
CALL PDBCQL(KODE, DUMMY, SPART, RUMMY, 1, ISKIP)
DD 109 L = 10, 18
109 AI(MA, L) = SPART(L - 9)
                                                                                                                                                                          COSTAI
     81.
      84.
                                                                                                                                                                          COSTAL
     85
     86.
87.
                                                                                                                                                                          COSTAL
               C
                                                          ARE THERE ANY TRANSVERSALITY CONDITIONS AT THIS PT.
                  111 IF(MA .GE. 18) GO TO 121

YES. COMPLETE AND INVERT AT MATRIX.

CALL BASIS(AI, MA, 18)

CALL GJRV(AI, 18, 1.E-12, IERR)

MAKE SURE INVERSION MORKED

MAKE SURE INVERSION MORKED
                                                                                                                                                                         COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
                                                                                                                                                                                           121
     88.
              C
     92. C
93.
94. C
95.
                            IF(IERR .NE. 0) CALL ERROR(CUSTAI -1, 1)'
ANALYZE TRANSVERSALITY CONDS.
                   ANALYZE TRÂNSVERSALÎTY CONDS.

L = MA + 1
DO 120 J = L, 18
CHECK FOR CONTINUOUS COSTATE
DO 112 I = 1
DIFF = ABS(AI(I, J) - AI(I + 9, J))
IF(DIFF - GT. 1.E-12) GO TO 115

112 CONTINUE

TOP MALE OF COLUMNIA S ROTTI
                                                                                                                                                                          COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
     98.
   100.
                                                         TOP HALF OF COL. EQUALS BOTTOM HALF. CHECK NUMBER OF NONZERO ENTRIES.
   102.
   103.
                            KK = 0

00 114 I = 1, 9

IF(ABS(AI(1, J)).LE. 1.E-12) GO TO 114

KK = KK + 1

IF(KK - 1) 114, 113, 119
104.
105.
106.
                                                                                                                                                                          COSTAI
COSTAI
COSTAI
   107.
   108.
                  113 11 = 1
  109.
                                                                                                                                                                          COSTAL
                           CONTINUOUS COSTATE
SO TO 120
   110.
                   114 CONTINUE
                                                                                                                                                                          COSTAL
                                                                                                                                                                          COSTAL
COSTAL
COSTAL
   111.
                                                                                                                                                                                                                  120-
                                                          CHECK FOR KNOWN COSTATE
                                                                                                                                                                          COSTAL
   115.
                   115 KK = 0
                                                                                                                                                                          COSTAI
                           KK = 0

DO 118 1 = 1, 18

IF(KK .EQ. 0 .AND, I .GT. 9) GO TO 119

IF(ABS(AI(I, J)).LE. 1.E-12) GO TO 118

KK = KK + 1
116.
117.
118.
119.
120.
                                                                                                                                                                          COSTAL
COSTAL
COSTAL
COSTAL
COSTAL
                                                                                                                                                                                                                             119-
                            KK = KK + 1
IF(KK - 1) 118,117,119
                                                                                                                                                                                          117-118
                                                                                                                                                                                                                             119
 121.
                   117 II = I
                                                                                                                                                                          COSTAI
                                                                                                                                                                         COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
  122.
123.
124.
125.
                    118 CONTINUE
                           KNOWN COSTATE
IICT(11, larc) = 1
GO TO 120
                                                         IF THIS 1S A LTAU MATCH AND TAU FOR PRECEEDING ARC
IS KNOWN, PASS UP TRANS. COND. AS TRIVIAL.
   127.
                                                                                                                                                                          COSTAL
                   119 IF(J .EQ. 17 .AND. IIC(B, IARC - 1) .EQ. 1) GO TO 120

ANOTHE NON-TRIV. TRANS. COND. STORE SHIFTED COLUMN
NNTTC = NNTTC + 1

ITCT(NNTTC, IARC - 1) = J - MA
                                                                                                                                                                         COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
  128.
129.
130.
131.
132.
                                                         STORE TOTAL NUMBER OF MON-TRIV. TRANS. CONDS. FOR THIS POINT
   133.
                    120 CONTINUE
                                                                                                                                                                          COSTAL
                                                                                                                                                                          COSTAL
  134.
                    121 LTAB( IARC - 1) = NNTTC
UPDATE TOTAL NUMBER OF UNKNOWN INITIAL STATES/CO-
STATES THROUGH THIS ARC AND STORE RESULT
  136.
137.
138.
139.
                                                                                                                                                                          COSTAL
                                                                                                                                                                         COSTAI
COSTAI
COSTAI
COSTAI
COSTAI
                    DO 122 I = 1, 9

IF(IABS(IIC(1, IARC) - 3) .LT. 2) NOKNOW = NOKNOW + 1

122 IF(IICT(I, IARC) .EQ. 2) NOKNOW = NOKNOW + 1

NOC(IARC) = NOKNOW -
   142
```

143. 144.	RETURN END	COSTAI
		
	•	
	•	

ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOCK	DC	SUBROUTIN	E USAGE
שטייד	STHBUL			BLUUK 1		3088 600	E THR
R	9 _r	I Gravita	tional acceleration at surface of the earth. (FT/SEC ²)	/GLOBAL/(1)	AL5 I APPLY I BRANPT I COSTAB I INTRPT I OUTPUT I OUTPUT I QLTOSZ I SALVE I STATEF I	GR GR GR GR GR GR GR GR GR
ARC	1	I Subarc	nusber. ~	/CNTRL /(24)	ARCIN I BCOND M BRANPT I CHECK M COSTAN I COSTAN I COSTAN I FORCES I INARC M INARC M MARCH I GLTOSZ I SALVE M MARCH M GLTOSZ I SALVE M MARCH M MARCH M GLTOSZ I SALVE M MARCH M MARCH M MARCH M GLTOSZ I SALVE M MARCH M M M M M M M M M M M M M M M M M M M	I ARC
С		codes fo	array conteining the initial condition or the QL state vector. The columns and to subarc starting points, the rows, to a variables.	\BFOCK \{	1)	BCOND M BRANPT I CHECK I COSTAB I COSTAI I COSTAI I TOSTAO I INTRPT I SALVE I	11C 11C 11C 11C 11C 11C
CT		for the the sub- column :	array containing the target condition codes state vector. The columns correspond to erc end points. The nonzero entries in a are the state target condition codes that t the end of the corresponding subarc.	\BLOCK /()	201)	CHECK I COSTAB M COSTAI M COSTAO O MAGIC D SALVE I	11CT 11CT 11CT 11CT 11CT 11CT
TC		codes fi correspi	array containing the initial condition or the QL costate vector. The columns and to subsrc starting points, the rops, to ste variables.	\BLOCK /('	401)	BCOND O BRANPT 1 CHECK COSTAB I COSTAB I COSTAI I ENOPT I INTRPT I	1TC 1TC 1TC 1TC 1TC 1TC 1TC
CT		the arra end point the numb Equation that concentration concentrations	array containing the QL costate analog to ay IICT. The columns correspond to subarc sis. The nonzero entries in a column are sers of those components of the vector 0 in 16.6-34 of Volume I of the PAD5 document stain the value of a costate target on that applies at the end of the	/BLOCK /((521)	BCOND D BRANPT I CHECK I COSTAB D COSTAI D INTRPT I MAGIC D	1 T C T 1 T C T
'AB		I An array	containing the number of nonzero entries column of the array IICT.	/BLOCK /(6		BCOND M BRANPT I CHECK I COSTAB I COSTAB I ENOPT I INTRPT I MAGIC I	BATL BATL BATL BATL BATL BATL BATL

SYMBOL	MATH ' SYMBOL	CODE	DESCRIPTION		STORA BLOCK	GE LOC	SUBROU SUBR		
LTAB			taining the number of nonzero entria on of the orray ITCT.	ıs /8	BLOCK /(821)	BCOND BRANPT COSTAB COSTAI INTRPT MAGIC	0	LTAB LTAB LTAB LTAB LTAB LTAB
		I Mass	-	3'S) /0	, (97)	AL4 AL7 AL8 AL9 BRANPT COSTABI COSTABI INTRPT NLDRVT OUTPUT SALVE WRAPUP	I I I I I	有民共共共共共共共共共共共共
NO C		of free (unk	taining a running total of the numbe nomn) state and costate variables, at each subarc.		LOCK /(842)	BNDRY BRANPT COSTAB COSTAI COSTAO INARC INTRPT SALVE WRAPUP	0 0 1 1	NOC NOC NOC NOC NOC NOC NOC
NO K NO W			mber of free (unknown) state and ables over all the subarcs.	/B	LOCK /(841)	CHECK COHOMO COSTAB COSTAI COSTAO GROPE MAGIC	M	NO KNO NO KNO NO KNO NO KNO NO KNO NO KNO
ZSAVE			d array containing the values from t of the state and costate at the init trajectory.		/(151)	BCOND BRANPT COSTAB COSTAI INTRPT PDBCOL SALVE	I I I	ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE

SUBRØUT I NE CØSTAO



COSTAO determines the costate initial conditions at the initial point.*

^{*}See Sections 16.6 and 17.1 in Vol. I.

```
SUBROUTINE COSTAO

THIS ROUTINE DETERMINES THE COSTATE INITIAL CONDS.
AT THE INITIAL

COMMON / BLOCK / IIC(10, 20), IIC(10, 20), ITC(10, 20), JTAB(20), BLOCK FITC(10, 20), ITAB(20), NOKNOW, NOC(20), VALIC(10, 20), BLOCK BL
                                                     1. C C 3. C C 5. C C 6. 7. 8.
                                                                                                                        COMMON /BLOCK/ IIC(10, 20), IICT(10, 20), ITC(10, 20), JTAB(20), *ITCT(10, 20), LTAB(20), MOKNOW, NDC(20), VALIC(10, 20), VALIC(10, 20), UPAY DIMENSION ABO(9, 9) DO 101 I = 1, 9 DO 101 J = 1, 9 TO 101 J = 1
旧
                                        13.
14. C
15. C
16.
17.
18.
                                                                                                                                                            ARE THERE ANY KNOWN COSTATES AT THE INITIAL PT.

IF(MA .GE. 9) GO TO 105

YES. FIND OUT WHICH ONES ARE KNOWN

CALL BASIS(AO, MA, 9)

CALL GJRV(AO, 9, 1.E-12, IERR)

L = MA + 1

DD 104 J = L, 9

IF(ABS(AO(1, J)) .LE. 1.E-12) GO TO 103

I[CT(1, 1) = 1

GO TO 104

CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          COSTAO
                                      20.
21. C
22.
23. C
                                                                                                                                 102 CONTINUE
                                      24.
25.
26.
27.
28.
29.
30.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          103~
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          164-
                             32.
                                                                                                                        103 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              COSTAO
                                   33.
34.
35.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          COSTAO
COSTAO
COSTAO
                                                                                                                          104 CONTINUE
                                                                                                                                                                                                                                                                                                                                                      SET TOTAL NUMBER OF UNKNOWN INITIAL STATES/COSTATES TO 8 AND STORE.
                                                                                                  Ç
                                      36.
37.
38.
39.
                                                                                                                             105 NGKNOW = 8
NOC(1) = NOKNOW
RETURM
END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          COSTAO
COSTAO
COSTAO
COSTAO
```



FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORA: BLOCK	LOC LOC	SUBROUTING SUBR COD	
110		9	A 10x20 array containing the initial condition codes for the QL state vector. The columns correspond to subarc starting points, the roms, to IL state variables.	/BLOCK /C	- 1)	BCOND M BRANPT 1 CHECK I COSTAB I COSTAI I COSTAI I INTRPT I SALVE I	11C 11C 11C 11C 11C 11C
1107		f t	10x20 array containing the target condition codes or the state vector. The columns correspond to he subarc end points. The nonzero entries in a olumn are the state target condition codes that ppiy at the end of the corresponding subarc.	/BLOCK /(201)	CHECK I COSTAB M COSTAI M COSTAO O MAGIC O SALVE I	IICT IICT IICT IICT IICT IICT
NO C		0	in array containing a running total of the number f free (unknown) state and costate variables at he start of each subarc.	/BLOCK /(842)	BMDRY I BRANPT I CDSTAB D COSTAI D COSTAO D INARC I INTRPT I SALVE I WRAPUP I	NOC NOC NOC NOC NOC NOC NOC
NOKNOW			he total number of free (unknown) state and ostate variables over all the subarcs.	/BLOCK /(841)	CHECK I COHOMO I COSTAB M COSTAI M COSTAO M GROPE I MAGIC I	NOKNOW NOKNOW NOKNOW NOKNOW NOKNOW NOKNOW NOKNOW



SUBRØUTINE DL1

DLI evaluates the constant engine deflection constraint,

$$\delta_E - C_{\delta_E} = 0.$$

```
SUBROUTINE DL1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DL1
DL1
DL1
DL1
DL1
DL1
DL1
DYNA
DYNA
DYNA
DYNA
DYNA
          2.
3.
4.
5.
6.
                                                                                                                                                                                           THIS ROUTINE APPLIES WHEN ENGINE DEFLECTION IS A CONSTANT
                                                                       LOGICAL SMITCH, ILOAD

REAL MACH, ISP ISPV, ISPR, ISPM, ISPT, ISPVV, ISPVR, ISPVM, ISPRR, ISPRR, ISPRM, ISPRT, ISPMM, ISPRT, ISPTT, LIFTV, LIFTV, LIFTVR, LIFT
     1Ó.
JUL21
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DYNA
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DYNA
DYNA
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          34.
35.
36.
37.
33911234456...
 61.
62.
63.
64.
65.
66.
67.
71.
72.
73.
                                                                         +DPDY(3, 8), DEPDEY(2, 8), DPDL(3, 3), PROD5(3, 64), PROD9(2, 24)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             MATS
```

```
76. COMMON /MATS/
77. *PV 'PG 'PP 'PR 'PO 'PVV 'PGV 'PPV 'PRV ' MATS
78. *POV 'PGG 'PPG 'PRG 'POG 'PPP 'PRP 'POP 'PRR ' MATS
79. *POR 'POO 'PLG 'PLP
80. EQUIVALENCE(PRODI,PROD5)
81. C
82. ENTRY DL10002
83. ENTRY DL1001
84. 40 XXZD = 1.
85. ENTRY DL1000
86. 50 XXZ = DELTAE - CDE
87. C
88. RETURM
89. RETURM
89. DL1
```



FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		BLOC	ORA(LOC	SUBROU SUBR		USAGE VAR
CDE	C.	ī	Value for engine deflection in case constant deflection constraint is used	engine (RADS)	/DYNA	/(156)	DL1	ı	COE
DELTAE	⁶ €	ī	Engine deflection	(RADS)	/DYNA	/(155)	ALGCON ARCIN CONTRL DL1 OUTPUT TRAJIN UT	# . # . I	DELTAE DELTAE DELTAE DELTAE DELTAE DELTAE DELTAE



SUBRØUTINE DL2

~--

.

--

.



DL2 evaluates the moment balance constraint, Equation 3.1-17in Vol. I. constraint with respect to the state and control as they are needed.

C	SUBROUTINE DL2					DL:
C C C	THIS CONS		LIES WHEN	ENGINE DEFLEC	TION IS NON-	DL. DL
C	COMMON/ARCDAT/					DL:
	+SREF ,EJ +latm ,Imode	,XISP ,JAER	,TMULT	, DTNC , GMAX	,DTPI ,	ARI
	#ILMAX HIJMAX				RAFA	A D
		. MAED	MAFF	MAFF	MAFC	AR
	*MI ,MISP	PILCA	AZCG	, MWDA , ZE	, muda ,	AR
	#MDB ,XCGR #DREF MCND	,ZCGR ,RHOB	, XE , QMULT	, REMAX	FRATE	ARI
	+OREF ,ACGN DIMENSION ARCDA(4) EQUIVALENCE(SREF,A)))	,			
	EQUIVALENCE (SREF, A)	(CDA)	-			ARI
	DIMENSION ARLUNCH EQUIVALENCE(SREF, A) LOGICAL SWITCH, IL REAL MACH, ISP, ISI *ISPVT, ISPRR, ISPRR *LIFTR, LIFTY *IRATED, ISPF, ISPFREAL MÁCHY, MACHR, REAL LIFTM, LIFTYM REAL LIFTM, LIFTYM	V. ISPR. ISP	PM. ISPT.	ISPVV. ISPVR.	ISPVA.	DY
	*ISPVT, ISPRR, ISPR	I, ISPRT, ISI	PMÁ, ISPÁT	ISPTT, LIFT	, LIFTÝ,	DY
	#LIFTR, LIFTA, LIFTS	V, LIFTVR, I	LIFTVA, LII	TRR, LIFTRA,	MUR, LIFTAA,	DY
	REAL MÁCHY, MACHR	MACHUR, MACH	1RR			DYI
		LIFTRÁ, LII	FTMM, LIFTI	1 A		
	COMMON /DYNA/ *XX TIME SING	m COSCAM OM	GA DEFGA	R G	SINA .	DY4
	-0000 '0000011'0-000	T, TAMP PA	,RO	CS TEMPI	SINA ,	DY
	#ROA ,CSR ,TEMPF #QQ ,QR ,QV	R, PARR , ROF	RR ,CSRR	KODE MACH	FVACH ,	DYI
	#QV OR OVV	R'EVACRR'EVE	CTT.T	MACHY MACH	; ISP ;	DY
	+ISPV ,ISPR ,ISPM	, ISPT , ISF	VV , ISPVR	ISPVA ISPV	T , I SPRR ,	DY
	#ISPRM ,ISPRT ,ISPMM	ISPMT ,1SF	TT LIFT	LIFTY LIFT	,LIFTA ,	DY
	*ISPV ISPR ISPM *ISPRM ISPRT ISPM *LIFTVV LIFTVM LIFTV *DRAGGV DRAGGR DRAGG *LIFTVM LIFTKM LIFTX *W SINPHI COSPH *MUR XKG XKP	A DRAGRE DE	GRA DRAGA	ALPHA PHI	LIFTM	DY
	*LIFTVM, LIFTRM, LIFT	M, LIFTMA, OBF	OBRR	GAMMAD, AE	,TAX	DYA
	+W ,SINPHI,CUSPH	I,SINPSI,COS	SPSI,SINRHO	, COSRHO, SINRE	OR, COSROR,	DYA
	*M SINPHI COSPH *MUR XKG XKP *XCGMM ZCGM ZCGMM *MACHRR SIN2RO COS2R *CMAM CMO CMOM *ULFTYA ULFTRR ULFTR *CDOMM CLAMM CLOM *SID DELTAE CDE *DB ULFT CULFT	XĴV XĴK	VVLX;	XJVR XJRR	MACHVR.	DY
	+MACHRR, SIN2RO, COS2R	D,CDS2GM,CM	, CMA	CMM CMAA	CMMM,	DYN
	*ULETVA ULETRR ULETR	A TPOW YAR	INM JULFIY	OLFIR OLFIR	ITETAA	DYA
	*CDOMM ,CLAMM ,CLCM	CLOMM DYN	1149,CT	CODAE SIDAE	,coo ,	DYN
	+SID DELTAE, CDE +DB ULFT CULFT	,XCG ,ZCG	ACE TIMES	,XMCG ,CALPH ,XMCGAA, IRATE	COD , IA, ALMAX , IO, FRATED	DYN
	COMMEN /DVNA/	, ULF 14 , 131	HGE, 11HE3	, ANLOHN, INNIE	,	DYN
	**************************************	, J3 , XMC	GA , FVACF	,ULFTAA,ISPF ,CLA ,CLM ,CDMM ,CDAM	, I SPFF ,	DYN
	*ILOAD FKM FKMM	SWITCH, INC	IF , CL	COMM CDAM	, CLAA , CYN198,	DYN
	+DYN199, DYN200, XMCGV	IMCGR IMC	GM .XMCGVV	.XMCGVR XMCGV	M. XMCGVA.	DYA
	*CLMM CLAM CD +DYN199 DYN200 XMCGW *XMCGRM XMCGRM XMCGR -DYN211 IDAM TAIRB *SFCV SFCH SFCVV DIMENSION PRODIC2,	A, XMCGMM, XMC	GMA, RORRR	, DYN214, DYN21	5,DYN216,	DYN
	*DYN217, IDAM , TAIRB	SECHH SEC	HBH, IMKDVV	, I MADAN, I AKBY	m, spl ,	JUL
	DIMENSION PRODICE,	64)	•••			MAT
	-01 00 00					MAT
	*P1 ,P2 ,P3 *XK10 ,XK2D ,XK3D	, XK1 , XK2	, XK3 A , XK3A	,XK1T ,XK2T	XK3T PDA	MAT
	+XK10 ,XK2D ,XK3D +XM19 ,XM20 ,XM21 +XK3TD ,XK1TA ,XK2TA	, XM22 , XK1	TT XK2TT	XKSTT , XKITO	XK2TD ,	MAT
	ATSXX, BIIXX, GTEXX*		DD , XK2DD	, XK3DD , XK1DA , XM44	, XK2DA , , XM45 ,	MAT
	***** X X X X X X X X X X X X X X X X X	XKIG XKZ	6 78436	, YKIP , VK2P	, 2032	MAT
	*XKIR ,XKZR ,XK3R	. ARIU ARZ	U AKSU	. ARIU . ARZU	. 4830 .	MAT
	*XK1M ,XK2M ,XK3M *XK1VD ,XK3VD	, XK12 , XK2	Z ,XK3Z	,00:31 ,00511	, , , , , , , , , , , , , , , , , , , ,	TAR
	#XK160 XK260 XK360	XKIGA XK2	GA XK3GA	, XK1VT , XK2VT , XK1GT , XK2GT , XK1PT , XK2PT , XK1RT , XK2RT	, , , , , , , , , , , , , , , , , , ,	MAT
	*XKIPD ,XK2PD ,XK3PD	,XKIPA ,XK2	24 , 24 3 2 4	, VVIOT , COAOT	, , , , , ,	TAR
				, XK10T , XK20T	XK3OT ,	TAR
	*XK10D XK20D XK30D *XK1UD XK2UD XK3UD COMMON /MATS/	XKIUA XKZ	UA , XK3UA	XKIMT XKZMT	,XK3AT	MAT
	COMMON /MATS/				******	TAR
	*XK1MD , XK2MD , XK3MD *XK1ZD , XK2ZD , XK3ZD				, XK3ZT ,	MAT
	**************************************	XKIPV XKZ	PV , XK3PV	XKIRV XKZRV	, XK3RV ,	MAT
	+XK10V , XK20V , XK30V	XK1UV XK2	UV ,XK3UV	XKIMY XK2MV	XK3MV ,	TAM
	AWITA 'WETA 'WUSTA	, ANIUG , ANZ	DOCAA DO	, ARIFO , ARZPO	, XK3P6 ,	MAT

```
76.
71.
18.
79.
                                                                                                                                                                                                                         MATS
                                                                                                                                                                                                                         MATS
MATS
MATS
    80.
81
62.
                                                                                                                                                                                                                       86.
87.
    88.
89.
90.
91.
92.
93.
95.
96.
97.
98.
100.
102.
                 ç
                                                                     THIS ENTRY COMP. 2ND PARTS.W/RESP. TO STATE
                                 ENTRY DL2020
ASSIGN 6 TO 160
60 TO 4
                                                                       THIS ENTRY COMP. MIXED PARTS, \mathbf{w}/\text{RESP}. TO STATE AND CONTROL.
                 CC
                                 ENTRY DL2011
ASSIGN 10 TO 160
GO TO 4
                                                                   THIS ENTRY COMP. 1ST PARTS. W/RESP. TO STATE
               ε
                                 ENTRY DL2010
ASSIGN 20 TO 16D
6D TO 4
104.
105.
106.
107.
108.
109.
110.
111.
112.
113.
114.
115.
116.
117.
                 C
                                                                     THIS ENTRY COMP. 2ND PARTS. M/RESP. TO CONTROL
                                 ENTRY DL2002
ASSIGN 30 TO 160
60 TO 5
                                                                     THIS ENTRY COMP. 1ST PARTS. W/RESP. TO CONTROL
               C
                                ENTRY DL2000
ASSIGN 50 TO 160
GO TO 5
               C
119.
120.
                            4 RAC = ZCGM+COD - XCGM+SID
HAC = -ZCGM+SID - XCGM+COD
                                                                                                                                                                                                                        DL2
DL2
                      # RRC = 2CGM*COD - XCGM*SID

HAC = -ZCGM*SID - XCGM*COD

5 XEMXCG = XE - XCG

ZEMZCG = ZE - ZCG

FAC = XEMXCG*SID - ZEMZCG*SID

SAC = XEMXCG*COD + ZEMZCG*SID

JJ1 = 1. - XJ

GO TO 160

6 XK2VV = XJVV*XMCG + 2 *XJV*XMCGV - XJ1*XMCGVV

XK2RV = XJV*XMCGM - XJ1*XMCGVM - XJ1*XMCGVR

XK2RV = XJV*XMCGM - XJ1*XMCGVM - XJ1*XMCGRR

XK2RR = XJR*XMCGM - XJ1*XMCGVM - XJ1*XMCGRR

XK2RR = XJR*XMCGM - XJ1*XMCGVM

XK2VM = XJV*XMCGM - XJ1*XMCGVM

XK2VM = XJV*XMCGM - XJ1*XMCGVM

XK2VM = XJV*XMCGM - XJ1*XMCGVM

XK2RM = XJR*XMCGM - XJ1*XMCGVM

XK2RM = XJ1*XMCGMM

XK2RM = RAC*T - XJ1*XMCGVM

XK2RM = RAC*T - XJ1*XMCGVM

XK2DD = T*FAC

XK2DD = T*FAC

XK2DD = T*FAC

XK2DD = T*FAC

XK2D = T*F(XEMXCG*COD + ZEMZCG*SID)

XK2M = FAC*T - XJ1*XMCG

50 XK2 = FAC*T - XJ1*XMCG

RETURN
 121.
                                                                                                                                                                                                                        124.
 128.
 130.
131.
132.
134.
135.
136.
137.
138.
139.
140.
141.
142.
143.
144.
145.
146.
                                                                                                                                                                                                                        DL2
DL2
DL2
DL2
                                                                                                                                                                                                                        DL2
DL2
DL2
DL2
DL2
DL2
DL2
               C
                                RETURN
```

DL2

150. END

FORTRAM Symbol	MATH Symbol	COL	E DESCRIPTION	ST BLOC	ORAG	LOC	SUBROUT Subr C	INE USAGE ODE VAR
COD	cosse	1	See symbol	/DYNA	/(153)	OUTPUT TH3	1 COD 1 COD 1 COD M COD
SID	siné _E	1	See symbol	/BYNA	/(154)	DL2 OUTPUT TH3	1 SID 3 SJD 1 SID M SID
1	T	I	Thrust (LBS)	/ DY NA	/(42)	ALGCOM (AL1 AL4 AL6 AL7 AL8 AL9 APPLY	M T T T T T T T T T T T T T T T T T T T
. ace	xce		Center of gravity body x station (FT)	/DYNA -	 	157)	DL2 STATEF I	x C G
XCGM	9x ^{ce} /9=	I	See symbol	/DYNA	/(108)	DL2 I STATEF F	1 XCGM
XCGMM	92X ^{Ce} \9#5	1	See symbol	/DYNA	/(109)	DL2 1 STATEF 1	A XCGMA
XE	ΧE	1	Engine thrust centroid body x station	/ARCDA	T/(34)	DL2	XE
XJ	ئ	1	Control blend factor	/DYNA	/(159)	ARCIM DL2 1 OUTPUT 1 STATEF 1	; x) ; x)
RLX	aj/aR	1	See symbol	/DYNA	/(113)	DL2 I STATEF C	X JR
ANCX	∂ ² j/∂R²	1	See symbol	/DYNA	/(116)	DL2 I STATEF C	N XJRR
XJV	ve\įe	1	See symbol	/DYNA	/(112)		ACX (
XJVR	a²j/avar	I	See symbol	/DYNA	/(115)	_	XJVR XJVR
XJVV	a ²]/av ²	1	See symbol	/ DYNA	/(114)	-	VVLX
XMCG	M _{CG}	1	Aerodynamic moment about center of gravity (FT-LBS)	/DYNA	/(160)		XMCG XMCG
XMCGA	∂M _{CG} /∂α	1	See symbol	/DYNA	/(176)		MEGA
XACGAA	∂ ² M _{CG} /∂α ²	ı	See symbol	/DYNA	/(169)	דט דע	
XMCGM	∂M _{CG} /∂■	1	See symbol	\ D Y NA	/(203)	DL2 I	

ORTRAN Symbol	MATH SYMBOL	COD	DESCRIPTION	BLOCK	ORAG	E LOC	SUBROU SUBR	CODI	USAGE VÁR
XMCGMA	∂ ² M _{CG} /∂m∂∝	1	See symbol	/DYNA	/(212)	DL2 UT	1	XMCGMA XMCGMA
XMCGMM	∂ ² M _{CG} /∂= ²	I	See symbol	/DYNA	/(211)	DL2 UT	I M	MAGONE
XACGR	∂M _{CG} /∂R	1	See symbol	/DYNA	/(202)	DL2 UT	I	XMCGR XMCGR
XMCGRA	∂ ² M _{CG} /∂R∂α	I	See symbol	/DYNA	/(210)	DL2 UT	I M	XMCGR
KACGRA	∂ ² M _{CG} /∂R∂∎	1	See symbol	/DYNA	/(209)	DL2 UT	I M	XMCGR/
XACGRR	∂ ² M _{CG} /∂α ²	1	See symbol	/DYNA	/(208)	DL2 UT	I	XMCGRI
CWCGA	aMcc/av	I	See symbol	/DYNA	/(201)	DL2 UT	I M	XWCEA
MCGVA	∂ ² M _{CG} /∂V∂œ	I	See symbol	/DYNA	/(207)	DL2 UT	ĭ	XMCGV
ACGVA	∂ ² M _{CG} /∂V∂■	I	See symbol	/DYNA	/(206)	DL2 UT	I	XMCGV
RCGVR	∂ ² M _{CG} /∂V∂R	ī	See symbol	/ DY NA	/(205)	DL2 UT	I	XMCGAI
CHCGVV	∂ ² M _{CG} /∂V ²	1	See symbol	/DYNA	/(204)	DL2 UT	ĭ	XMCGAK
rce.	- ^Z cG	ĭ	Center of gravity body z station (FT)	/DYNA	/(158)	DL2 STATEF UT	I I I	Z C G Z C G Z C G
CGM	∂Z _{CG} /∂m	I	See symbol	/DYNA	/(110)	DL2 STATEF UT	I R I	ZCGM ZCGM ZCGM
CSMM	a2Z _{CG} /a=2	i	See symbol	/ DY NA	/(111)	DL2 STATEF UT	î A I	ZCGMM ZCGMM ZCGMM
E	ΖE	I	Engine thrust centroid body z station	/ARCDAT	/(35)	DL2 UT	I I	ZE ZE

•

SUBRØUTINE ENDPT



ENDPT evaluates the state and costate target misses at the endpoint of a branch. It also computes the partials of these misses with respect to the c's*.

^{*}See Sections 16.6 and 17.4 of Vol. I.

```
ENDPT
ENDPT
ENDPT
      1.
2.
3.
4.
5.
6.
7.
8.
                             SUBROUTINE ENDPT(DPZIDC, KK)
                                                        THIS ROUTINE EVALUATES THE STATE AND COSTATE TARGET MISSES AT THE END POINT OF A BRANCH. IT ALSO COMPUTES THE PARTIALS OF THOSE MISSES WITH RESPECT TO THE C+S.
                                                                                                                                                                 ENDPT
ENDPT
ENDPT
                                                                                                                                                                 ENDPT
                          JUL21
                                                                                                                                                                 CATRL
CATRL
CATRL
CATRL
CATRL
CATRL
CATRL
GLOBAL
       18.
      20.
21.
22.
                                                                                                                                                                BLOCK
BLOCK
BLOCK
BLOCK
BLOCK
BLOCK
BLOCK
BLOCK
      23
24.
25.
      26.
27.
28.
29.
                                                                                                                                                                EVAL
                                                                                                                                                                Z
ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
      33.
                          IS THIS THE LAST ARC

IF(IARC .NE. NARC) 60 TO 104

YES. ADD PAYOFF PARTIALS TO BF VECTOR.

IF(IPAY .NE. 9) 60 TO 1011

BF(8) = BF(8) + 1.

GO TO 104

CONTINUE
      36.
37.
Ы
       40.
               C
                                                                                                                                                                 ENDPT
SEP15
SEP15
SEP15
                ε
      44
                  SEP 15
ENDPT
      46.
47.
                                                                                                                                                                                 102-
     48.
49.
50.
                                                                                                                                                                 ENDPT
                                                                                                                                                                ENDPT
                   102 15KIP = 0
CALL POBCQL(IPAY, VAL, SPART, RUMMY, 1, 15KIP)
00 103 I = 1 9
103 BF(I) = BF(I) - SGN*SPART(I)
STORE THE NUMBER OF STATE TARGET CONDS. AT THIS PT.
AND SET INDEXES.
     51.
52.
53.
54.
55.
                                                                                                                                                                ENDPT
ENDPT
ENDPT
ENDPT
О
                                                                                                                                                                 ENDPT
     57.
58.
59.
60.
                   104 MTARG = JTAB(IARC)

IF = MTARG + 1

IL = 9 - MTARG

IP = L + MTARG
                                                                                                                                                                ENDPT
                                                                                                                                                                 ENDPT
ENDPT
ENDPT
                            ARE THERE ANY STATE TARGETS.

IF(MTARG .GT. 0) GO TO 106

NO. THE TRANSVERSALITY CONDS. ARE SIMPLY THE BF
VECTOR
               C
                                                                                                                                                                 ENDPT
                                                                                                                                                                 FNOPT
                                                                                                                                                                                106
                                                                                                                                                                 ENDPT
ENDPT
               č
     64.
65.
66.
67.
68.
69.
71.
                   00 105 I = 1, 9
K = L + I
105 PZI(K) = BF(I)
60 TO 113
                                                                                                                                                                 FNDPT
                                                                                                                                                                ENDPT
ENDPT
ENDPT
                                                                                                                                                                                           113-
                                                       SET UP THOSE ROWS OF THE AF MATRIX THAT RESULT FROM THE STATE TARGETS. AT THE SAME COMPUTE THE TARGET MISSES AND THEIR PARTIALS W/RESP. TO C+S.
               CCC
                                                                                                                                                                ENDPT
                                                                                                                                                                ENDPT
                   106 DO 111 I = 1, MTARG
                                                                                                                                                                ENDPT
     72.
                                                                                                                                                                ENDPT
```

6 CCT 72 6 01-44

```
74.
75.
76.
77.
78.
79.
80.
                                                              KODE = ITC(I, IARC)
IF(KODE .GT. 11) 60 TO 108
SIMPLE RELATIVE STATE MATCH
KODE = MAP(KODE)
                                                                                                                                                                                                                                    ENDPT
                                                                                                                                                                                                                                    ENDPT
ENDPT
ENDPT
                                                                                                                                                                                                                                                        108
                                                   RUDE = MAP(KODE)

AF(I, KODE) = 1

TARGET MISS

PZI(K) = NOM(KODE) - VALTC(I, IARC)

PARTS. W/RESP. TO C*5 OF TARGET MISS.

107 DPZIDC(K, J) = 5(KODE, J + 1)

GO TO 111

COMPLEX CONDITION ON THE STATE
                                                                                                                                                                                                                                     ENDPT
                                                                                                                                                                                                                                     ENDPT
ENDPT
                                             C
                                             C
                                                                                                                                                                                                                                     ENDPT
                                  82.
                                                                                                                                                                                                                                    ENDPT
                           ld
                                  83.
84.
85.
                                                                                                                                                                                                                                                                     111-
                                                                                                                                                                                                                                     ENDPT
                                                                                                COMPLEX CONDITION ON THE STATE
                                                                                                                                                                                                                                    ENDPT
                                            108 ISKIP = 0
CALL PDBCQL(KODE, VAL, SPART, RUMMY, 1, ISKIP)
DO 109 J = 1, 9
109 AF(I, J) = SPART(J)
C TARGET MISS
PZI(K) = VAL - VALTC(I, IARC)
CALL MATMLT(TEMP, SPART, S(1, 2), 1, 18, NOCK)
C PARTS. W/AESP TO C+S OF TARGET MISS.
DO 110 J = 1, NOCK
110 DPZIDC(K, J) = TEMP(J)

111 CONTINUE
                                86.
87.
88.
89.
90. C
91.
92.
93. C
                                                                                                                                                                                                                                    ENDPT
                                                                                                                                                                                                                                   ENOPT
ENOPT
ENOPT
ENOPT
ENOPT
                                         CALL BASIS(AF, MTARG, 9)
CALL BASIS(AF, MTARG, 9)
CALL GJRV(AF, 9 1.E-12, IERR)
MAKE SURE JUVERSION OX.

IF(IERR .NE. 0) CALL ERROR(ENDPX, -1 1)
C
CALL MATMLT(VAL BF, AF(1, IF), 1, 9, IL)
DO 112 I = 1, IL
K = IP + I
112 PZI(K) = VAL(I)
C
EVAL PARTY
                                                                                                                                                                                                                                     ENDPT
                                                                                                                                                                                                                                    ENDPT
                               96. 111 CONTINUE
97. C
98. CALL BASIS
99. CALL GJRV(
                                                                                                                                                                                                                                    ENDPT
                                                                                                                                                                                                                                   ENOPT
ENOPT
ENOPT
ENOPT
                                101.
102. C
103.
                                                                                                                                                                                                                                    ENDPT
ENDPT
                                                                                                                                                                                                                                    ENDPT
                                                                                                                                                                                                                                    ENDPT
                                                                                                                                                                                                                                   ENDPT
                               106.
107.
108.
                                                                                              EVAL. PARTS. W/RESP TO C+5 OF TRANS. CONDS. BY
DIVIDED NUMERICAL DIFFERENCES.
                                                                                                                                                                                                                                    F NOP 1
                                                  ENDPT
                              109.
110. C
                                                                                                                                                                                                                                   ENDPT
                        110.

111.

112.

113.

114.

115.

116.

117.

118.

119.

120.

121.
                                                                                                                                                                                                                                   ENGPT
                                                                                                                                                                                                                                    ENDPT
                                                                                                                                                                                                                                   ENDPT
ENDPT
ENDPT
                                          Ç
                                                                                                                                                                                                                                   ENDPT
ENDPT
ENDPT
ENDPT
                                            C
                                                                                                                                                                                                                                   ENDPT
ENDPT
SEP15
                                                                                                                                                                                                                                                       117-
                                               1141 CONTINUE

IF(IPAY .GT. 11) GO TO 115

KODE = MAP(IPAY)

BF(KODE) = BF(KODE) - SGM

GO TO 117
                                                                                                                                                                                                                                   SEP15
ENDPT
                               124.
                               125.
126.
127.
                                                                                                                                                                                                                                                      115-
                                                                                                                                                                                                                                   ENDPT
ENDPT
ENDPT
                               128
                                                 115 ISKIP = 0
CALL PDBCQL(IPAY, VAL, SPART, RUNNY, 1, ISKIP)
DD 116 J = 1, 9
116 BF(J) = BF(J) - SGN*SPART(J)
ANY STATE TARGETS
                         129.
130.
131.
132.
                                                                                                                                                                                                                                   ENDPT
                                                                                                                                                                                                                                  ENDPT
                                                                                                                                                                                                                                   ENDPT
                                                                                                                                                                                                                                   ENDPT
                               133.
                             133. C ANY STATE TARGETS

134. 117 JF(MTARG .GT. 0) GD TO 119

135. C NO. JUST TAKE DIVIDED DIFF. OF BF VECTOR

136. DO 118 J = 1, 9

137. K = L + J

138. 118 DPZIDC(K, I) = (BF(J) - PZI(K))/DC

139. GO TO 124

140. C RECOMPUTE AF INVERSE
                                                                                                                                                                                                                                  ENDPT
                                                                                                                                                                                                                                   ENDPT
                                                                                                                                                                                                                                   ENDPT
ENDPT
ENDPT
                                                                                                                                                                                                                                   ENDPT
                                                                                                                                                                                                                                                                    124
                             140.
                                                                                              RECOMPUTE AF INVERSE
                                                  MECOMPUTE AF

119 00 122 J = 1, MTARG

KODE = ITC(J, IARC)

IF(KODE .GT. 11) 60 TO 120

KODE = MAP(KODE)

AF(J, KODE) = 1
                               141.
                                                                                                                                                                                                                                  ENDPT
                            142.
143.
144.
145.
                                                                                                                                                                                                                                  ENDPT
ENDPT
ENDPT
ENDPT
                                                                                                                                                                                                                                                     120-
6 OCT 72 8.01-44
```

```
60 TO 122

120 ISKIP = 0
    CALL POBCQL(KODE, VAL, SPART, RUMMY, 1, ISKIP)
    DO 121 K = 1, 9

121 AF(J, K) = SPART(K)

122 CONTINUE
    CALL BASIS(AF, MTARG, 9)
    CALL BASIS(AF, 9, 1.E-12, JERR)
    CALL BASIS(AF, 9, 1.E-12, JERR)
    CALL MATMLT(VAL, BF, AF(1, IF), 1, 9, 1L)
    COMPUTE DIVIDED DIFFS.

123 DP2IDC(K, 1) = (VAL(J) - P2I(K))/DC

124 CONTINUE
                                                        60 TO 122
                                                                                                                                                                                                                                                                                                                                ENDPT
                                                                                                                                                                                                                                                                                                                                                                                    122
146
147.
148.
150.
151.
152.
153.
154. C
155.
156. C
                                                                                                                                                                                                                                                                                                                               ENDPT
ENDPT
ENDPT
ENDPT
                                                                                                                                                                                                                                                                                                                               ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
                                                                                                                                                                                                                                                                                                                              ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
ENDPT
     160.
161. C
162. C
163.
164.
165.
                                                                                                             ADD 9 TO THE NUMBER OF STATE/COSTATE TARGET MISSES COMPUTED.
                                                      L = L + 9
RETURN
END
```

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORA BLOCK	GE LOC	SUBROUTINE USAGE SUBR CODE VAR
J. 1150E	JIMBUL			BLUCK	L00	SOUR CODE AND
DC	Δc;	1	Small perturbation of a c.	/EVAL /(867)	BNDRY D DC BRANPT I DC ENDPT I DC INTRPT I DC
DZ	Δc ₁ h ₁ (I ⁻)		An 18 mord array that contains the second term on the right hand side of Equation 17.4-11 of Vol.I of this document.	/EVAL /(BRANPT I DZ ENDPT I DZ INTRPT I DZ
IARC	1	1	Subarc number.	/CNTRL /(24)	ARCIN I IARC BCOND M IARC BNDRY M IARC BRANPT I IARC CUSTAM I IARC CUSTAM I IARC CUSTAM I IARC FORCES I IARC INARC M IARC INARC M IARC MAGGIC M IARC MAGGIC M IARC OLTOSZ I IARC SALVE M IARC SALVE M IARC MARQUP M IARC
	-		A 10x20 array containing the initial condition codes for the QL costate vector. The columns correspond to subarc starting points, the rows, to QL costate variables.	/BLOCK /(401)	BCOND O ITC BRANPT I ITC CHECK I ITC COSTAB I ITC COSTAI I ITC ENDPT I ITL INTRPT I ITC
JTAB		1	An array containing the number of nonzero entries in each column of the array IICT.	/BLOCK /(601)	BCOND M JTAB BRANPT I JTAB CHECK I JTAB COSTAB I JTAB COSTAI I JTAB ENDPT I JTAB INTRPT I JTAB MAGIC I JTAB
L			Total number of target conditions to satisfy in the problem.	/E4AL /(868)	BNDRY M L BRANPT M L ENOPT M L INTRPT M L
MAP		I	A 10 mord array that maps the steepest descent state vector into the ΘL state vector.	/EVAL /(20)	BNDRY D MAP BRANPT I MAP ENDPT I MAP INTRPT I MAP
NARC	Ng	Ī	Number of subarcs in the problem.	/GLOBAL/(BCOND I MARC BNDRY I MARC CHECK I MARC ENDPT I MARC ENVPRO I MARC FETCH I MARC INARC I MARC MAGIC I MARC QLTOSZ I MARC GLTOSZ I MARC WARPUP I MARC WARPUP I MARC
NOCK	•1	1	The number of c's in the vector C ₁ defined by Equation 17.4-4 of Vol.i of this document.	/EVAL /(BNDRY # NOCK BRANPT I NOCK ENDPT I NOCK INTRPT I NOCK



FORTRAN SYMBOL	MATH Symbol	COD	DESCRIPTI	ON	ST BLOC	ORA	GE LOC	SUBFOUT SUBR (INE U	SAGE VAR
NOM	V	1	Relative velocity.	(FT/SEC)	/D	11	91)	ENDPT ENVPRO FETCH	O NO	M M M
-	-			•			•	NLDRV NLDRV OUTPUT PDBCQL STATEF	O NO I V I V	
PZI		A	A 40 word array that contains the misses for all the target condition problem.	target condition ons in the	/EVAL	/(30)	BRANPT	M PZ	i I
S	•	1	An 18x41 array used to store the homogeneous solutions on the early point.		/EVAL	/(BRANPT	1 S 1 S 1 S	
SGN		ī	Sign of the variable SIG in the 65 block /60BAL/. SGN = +: payoff to be maximi SGN = -: payoff to be minimized	ıed;	/EVAL	/(1)		0 561 1 561	
SPART		1	An 18 word array whose first nine the values of the partial derivati of those target conditions compute PDBCQL.	ives ort the state	/EVAL	/(2)	BRANPT	D SP/ 1 SP/ 1 SP/ 1 SP/	ART ART
TEMP	(94¹\9C¹) _↓	ī	A 40 word array that contains the vector defined by Equation 17.4-9 document.		/EVAL	/(869)	BRANPT ENDPT INTRPT	I TEA	MP
VALTC		1	A 10x20 array containing the desir state target conditions whose code array IICT.	ed values of the es appear in the	/BLOCK	/(1062)	BRANPT CHECK ENDPT	I VAL	LTC LTC LTC LTC LTC
z		ī	A 20 word array used to store the solution from the preceding QL Ite		/1	/(1)	BRANPT ENDPT ENVPRO INTERP INTERP LINDRY NOMNAL OUTPUT RKUTT1 RKUTT2 SALVE	1 Z M Z 1 Z 0 Z	



SUBRØUT I NE ENVPRQ

ENVPRQ calculates and stores environmental trajectory parameters from a converged QL trajectory for use in the SSSP sizing module.

.. -

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1.
2. C
3.
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5.
6.
                                                                 SUBROUTINE ENVPRO
COMPUTE ENVIRONMENTAL PARAMETERS THAT AFFECT WEIGHT
DATA RAD/57.2957795130823/
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AU609
                                                                  **SFCV | SFCW | SFCWN | SFCWN | SFCWN | REAL MAGBW, MU, M, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM **LHT | COMMON /D/ **X | M, XI(4), MAGBW, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI, **ALT, ARO, MU, M, TAU, HT, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, HT, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, LMT, D169, D110, BV(40), 2SAVE(20), 01(20), NPOINT(20), DELT(20) DIMENSION NOM(20) | EQUIVALENCE (NOM, V) COMMON /2D/ 20(50) | SECONDON /2D/ 20(50)
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 48.

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5121MG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             54(20),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TWRAT2,
TWRATO,
1PSMAX,
1SPB,
 63.
83:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    SIZING
SIZING
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                                                         10 IF( | IARC.GE.IFIX(SQ(1,3))) RETURN
IF( Q.LE. QLIM ) RETURN
QLIM = Q
SQ(5,1) = TIME
SQ(6,1) = R-ER
SQ(7,1)= V
70.
71.
72.
73.
74.
75.
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JUL21
JUL21
JUL21
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JUL21
```

```
SQ(8,1)= GAM+RAD
SQ(9,1) = MACM
RETURN
11 BRANCH TRAJECTORY TEST
                                                                                                                                                                                                                          JUL21
JUL21
JUL21
JUL21
                                                                                                                                                                                                                                              10-1
                      100 IF(IARC.LE.NSB) GO TO 10

1F(IFIX(SQ(1,3)).LE NSB*NSAB) GO TO 120

IF(IARC.GT.NSB.AND IARC LE.NSB*NSAB) GO TO 200

RETURN
                                                                                                                                                                                                                          JUL21
JUL21
JUL21
JUL21
    80
    81
82
83
                                                                                                                                                                                                                                                              200-
                                                                                                                                                                                                                                               200
                      120 IF(1ARC.GT.NSB+NSAB) GO TÔ 200
RETURN
111 ENTRY TRAJECTORY PAR
                                                                                                                                                                                                                          JUL21
JUL21
JUL21
    84.
85.
                                                          ENTRY TRAJECTORY PARAMETERS Q+SLPHA AND HEAT RATE
    86
                     200 CONTINUE

QALF = Q+ALPHA+RAD

1F(QALF.GT.SV(1) ) SV(1) = QALF

TLOFAC = SQAT(LIFT+LIFT +DRAG+DRAG) / W

1F(TLOFAC.GT.SV(27)) SV(27)= TLOFAC

11A THRESHOLD HEAT LOAD AND TIME

1F(TMRESH.GT.0) GO TO 220

1F(ZD(9).LT. SQ(30,2)) RETURN

THRESH = TIME

MT1=Z(9)

RETURN
                                                                                                                                                                                                                         JUL21
    87.
    88.
89.
90.
91.
92.
93.
94.
95.
                                                                                                                                                                                                                                              220-
                     JUL21
 98.
99.
100.
101.
102.
103.
104.
105.
106.
 108
                            7 INTB=0
                                                                                                                                                                                                                         JUL21
109.
110.
111.
112.
                            8 CONTINUE
THRESH =0.
RETURN
END
                                                                                                                                                                                                                         JUL21
JUL21
JUL21
JUL21
```

FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION	J	STORAGE BLOCK LO	SUBROUTINE USAGE IC SUBR CODE VAR
ALPHA	Q	I Angle of sttack	(RAD)	/DYNA /4	79) AEROCO I ALPMA ALGCON M ALPMA AL2 I ALPMA ARCIN M ALPMA CONTRL M ALPMA ENVPRG I ALPMA MOMECO I ALPMA NPLANE M ALPMA TRAJIN O ALPMA UT I ALPMA WRAPUP I ALPMA
DRAG	D	I Aerodynamic drag	(LBS)	/DYNA /(69) AL5 I DRAG AL7 I DRAG AL8 I DRAG AL9 I DRAG AL9 I DRAG CONTRL I DRAG CONTRL I DRAG ENVPRQ I DRAG OUTPUT I DRAG OUTPUT I DRAG TH3 I DRAG UT M DRAG
ER	ER	I Earth radius.	(FT)	/GLOBAL/(2) ENVPRO I ER POBCOL I ER OLTOSZ I ER STATEF I ER
GAM	7	1 Relative flight path angle.	(RAD)	/0 /(92) ARCIN I GAM ENVPRQ I GAM DUTPUT I GAM STATEF I GAM WRAPUP I GAM
LIFT	L	I Aerodynamic lift	(LBS)	/DYNA /(ALS I LIFT ALS I LIFT ALG I LIFT APPLY I LIFT CONTRI I LIFT ENWPRQ I LIFT OUTPUT I LIFT TM3 I LIFT UT O LIFT
MA CH	Ħ	[Mach number		/DYNA /(;	26) AEROCO I MACH ENVPRO I MACH OUTPUT I MACH STATEF M MACH
NARC	N ₃	I Mumber of subarcs in the problem.		/GLOBAL/(18) BCOMD I MARC BMORY I MARC CHECK I MARC EMPT I MARC ENVPRO I MARC FETCH I MARC IMARC I MARC MAGIC I MARC OLTOSZ I MARC SALVE I MARC WRAPUP I MARC
NBR AN	N I	I Number of the last subarc on the ste problem. If the problem is not a br then NBRAM = Q.		/GLOBAL/(BNDRY I NBRAM BRAMPT I NBRAM COSTAB I NBRAM ENVPRO I NBBAM INTRPT I NBBAM MAGIC I NBRAM QLTOSZ I NBRAM SALVE I NBRAM

10 NOV 72 6.01-47

FORTRAN	MATH	CODE	DESCRIPTION		STOR		SUBROUT	INE USAGE
SYMBOL	SAMBOL		DESCRIFTION		BLOCK	cac	SUBR C	ODE VAR
NFARC	N ₂	1	Number of the last suberc on the first bren the problem is not a branch problem, then N MARC.		/GLOBAL/	(20)	BADRY BRANPT COSTAB ENVPRO INTRPT MAGIC QLTOSZ	I WFARC I WFARC I WFARC I WFARC I WFARC I WFARC I WFARC
•	4		Dynamic pressure (LBS/FT ²)	/DYNA /	(27)	ENVPRO OUTPUT PDBCQL STATEF	
OLIM		M	Saved value of maximum dynamic pressure.		/5121NG/	(264)	ENVPRO	M GLIM
R	R	1	Radial distance from earth center to wehicl	• (FT)	/BYNA /	(7)	ALT ALB AL9 CONTRL ENVPRO NLDRV POBCOL	I A I A I A I A I A I A I A I A
SQ		H	A synthesis data array (37,5) that contains flyback data and some injection quantities	the	/5121NG/	(74)	ENVPRO OLTOSZ	
SV		M	A synthesis array (28) containing staging parameters and misc flags		/SIZING/	(46)	ENVPRO OLTOSZ	M SV
TIME		I	Trajectory time	(SEC)	/BYMA /	(2)	OUTPUT POBCOL	I TIME I TIME I TIME M TIME I TIME
٧	•	1	Relative velocity.	(FT/SEC)	/D /	(91)	AL4 AL8 BCORRPT BROMPPT O BROMPPT O ENCYPPT INCORPT INCORPT MLOTPUT OUTBCOF STATE	I V I V I V I V I V I V I V I V I V I V
u	ų	ı	We i ght	(LB\$)	/DYNA /	91)	AL5 ENVPRO OUTPUT POBCOL OLTOSZ STATEF	I # I # I # I #



FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLO	TORA	GE LOC	SUBROL SUBR	CODE	USAGI VAR
ı	Z	1	A 20 mord array used to store the total linear solution from the preceding QL iteration.	/1	/(1)	BRANPT ENDPT ENVPRO INTERP INTERP LINDRY NOMNAL OUTPUT RKUTTI AKUTTI	I	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
20		1	A 20 mord array containing the vector f(X,Z,W) in Equation 17.1-7 in Vol.1 of this document.	/20	/(1)	ENVPRO LINDRY OUTPUT RKUTTS WRAPUS	1 1 2 1	20 20 20 20 20



SUBRØUT I NE ERRØR



ERROR is a general error message routine for the QL module.

```
SUBROUTINE ERROR(REGION, KOD, IRETRN)
ERROR
                                                                               THIS ROUTINE SERVES AS A GENERAL ERROR MESSAGE ROUTINE FOR THE QTINE FOR THE QL MODULE REGION IS THE 6 HOLLERITH CHARACTER NAME OF THE SUBROUTINE IN WHICH THE ERROR OCURRED, KOD IS THE CODE NO. OF THE ERROR AND IRETRN INDICATES WHETHER THE PROBLEM SHOULD BE RESTARTED WITH A BETTER STEEP. DESC. INITIAL ARC.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     FRROR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ERROR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       FRROR
                                                         REAL MAGBY, MU, M, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM

LHT
COMMON /D/

X, M, XI(4), MAGBY, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI, LALT, MO, M, TAU, HT, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, LHT, D109, D110, SV(40), ZSAVE(20), D1(20), NPO1NT(20), DELT(20)

EQUIVALENCE (NOM, V)
LOGICAL SWITCH, LLOAD

REAL MACH, ISP, ISPV, ISPR, ISPM, ISPM, ISPMT, ISPVN, ISPVM, ISPVM, ISPVN, ISPVM, ISPVN, ISPVM, ISPVN, ISPVM, ISPVN, ISPVM, 
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ERROR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     JUL21
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GLOBAL
                                                            COMMON/SLOBAL

GRA

GRA

TRMAX,JJDP(6)

FATAL NARC ,NBRAN ,NFARC ,10(4) ,KTAB(20),

FITAB(20) ,SIG MAXTAB,GM,PSIAF ,IPFLG1 ,IPFLG2,IPFLG3,IPFLG4,

FINEQF(20) ,IFPSO, KSOL , INARK,KGLOBAL(7)

FORMAT(1NO, 5H+**** ,A6 ,10M EARDR NO., 12, 5H*****)

FORMAT(1NO, 5H***** ,A6 ,10M EARDR NO., 12, 5H*****)

K = IABS(KOD)

WRITE(6, 1) REGION K

IF KOD POSITIVE,WARNING DNLY.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GLOBAL
GLOBAL
ERROR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   FRROR
                           ε
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   FRROR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     101-102-
 63
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                FRROR
                                              101 KGLOBL = 1
CALL PDUMP(X, DELT(20),1,XX, IDAM, 1)
SHOULD STEEP. DESC. TRY RESTART.
FATAL QL ERROR.
IF(IRETRN .NE. 0) IFATAL = .TRUE.
CALL QLERR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ERROR
ERROR
ERROR
 64.
65.
 66.
67.
68.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ERROR
ERROR
ERROR
 70.
                                               102 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                FRROR
```

FORTRAN SYMBOL	MATH SYMBOL	COD	DESCRIPTION	BLOCI	ORAI	LOC	SUBROU SUBR		USAG! VAR
DELT		1	A twenty word array containing the quasitime compute interval for each subarc.	/D	/(211)	CHECK ERROR I NARC	0 1 1	DELT DELT DELT
IDAM		1	Optional atmospheric calculations flag. IDAM = -1: Compute $\partial^3 \rho_a/\partial R^3$; IDAM = 0. No optional calculations; IDAM = 1: Compute $\partial^3 \rho_a/\partial R^3$, μ_a , $\partial \mu_a/\partial R$, etc.	/DYNA	/(218)	ARCIN ERROR NPLANE STATEF WRAPUP	1	IDAM IDAM IDAM IDAM IDAM
IFATAL		0	Fatal error flag.	/GLOBA	L/(17)	ERROR	0	IFATAL
KGLOBL		0	A seven word array not used.	/GLOBA	L/(96)	ERROR	0	KGLOB
· -	х .	ι	The quasitime variable.	/0	76		AL4 BNDRY FETCH S INTERP MADAMS RKUTTE SALTE WRAPUP	***************************************	X
		1	Fraction of subarc that has transpired	/DYNA		1)	ARCIN ERROR OUTPUT STATEF	Ī	XX XX XX

SUBROUTINE FETCH

FETCH retrieves the state/costate vector from the initial arc at the early and/or late sides of corner points.

```
1. CC CC CC 6. CC 7. 8. 9. 10. 11.
                                             SUBROUTINE FETCH( IARC )
                                                                                                                                                                        FETCH
                                                                                                                                                                      FETCH
FETCH
FETCH
FETCH
FETCH
ARCDAT
                                                                       THIS ROUTINE RETRIEVES THE STATE/COSTATE VECTOR FROM THE INITIAL ARC AT THE EARLY AND/OR LATE SIDES OF CORNER PTS.
                                          ARCDAT
ARCDAT
ARCDAT
                                                                                                                                                                       ARCDAT
ARCDAT
ARCDAT
ARCDAT
                         11.
12.
13.
14.
15.
16.
17.
18.
20.
21.
                                                                                                                                                                       ARCDAT
                                                                                                                                                                       GLOBAL
                                                                                                                                                                        GLOBAL
                                                                                                                                                                       GLOBAL
                                          23.
24.
25.
26.
27.
28.
29.
30.
31.
                                                                                                                                                                       JUL21
                                                                                                                                                                       FETCH
FETCH
FETCH
FETCH
                                          33.
                                                                                                                                                                       FETCH
FETCH
FETCH
FETCH
                         34.
35.
                               C
                                C
                         36.
37.
                                                                                                                                                                                    101-
                        36.
39.
40.
41
42.
                                C
                                            VES. INITIALIZE INITIAL ARC FILE.

REMIND INARK
READ(INARK) TO, NS, NARCTP, (OTP(IJ), IJ = 1, NARCTP)
IF(NARCTP NE. NARC) CALL ERROR(FETCHX, -1, 1)
READ(INARK) KARC, TIRE, SKIP, SCS
IPASS = 1
                                                                                                                                                                       FETCH
                                                                                                                                                                       FETCH
                                                                                                                                                                      FETCH
FETCH
FETCH
                                                                      INITIALIZE LOGICAL PARAMETERS
                         44
                                    101 ISON = 1
JARC = 0
IARCS = IARC
                                                                                                                                                                      FETCH
FETCH
FETCH
                         45.
                        45.
46.
47.
48. C
49.
50. C
51.
52.
                                            IS THIS A CALL FOR THE INITIAL PT. OF THE FILE.

IF(IARC .EQ. 0) GO TO 100

NO. SET UP LOGICAL PARAMETERS.

JARC = IABS(IARC)

ISAN = IEIGNU 1000
                                                                                                                                                                      FETCH
FETCH
FETCH
                                                                                                                                                                                     100-
                                            JARC = IADDITATION | TARC |
POSITION FILE TO DESIRED PT
                                                                                                                                                                      FETCH
FETCH
                        54
55.
56
                                     100 IF(JARC .GT. KARC) 60 TO 102
REWIND INARK
READ(INARK) TO
                                                                                                                                                                      FETCH
                                                                                                                                                                      FETCH
FETCH
                                     102 READINARK) KARC TIME SKIP, SCS
IF(EOF, INARK) 163, 109
103 IF(JARC .ED. NARC .AND. ISGN .LT. 0) GO TO 104
CALL ERROR(FETCHX, -2, 1)
                        57.
58
                                                                                                                                                                      FETCH
FETCH
                                                                                                                                                                                     103-7109-
                        59.
60.
                                                                                                                                                                      FETCH
FETCH
                                                                                                                                                                                                            104-
                                     104 BACKSPACE INARK
BACKSPACE INARK
READLINARK) KARC TIME SKIP SCS
SET UP STATE/COSTATE VECTOR AND COMPUTE ANY OTHER
QUANTITES THAT MAY BE NEEDED.
                                                                                                                                                                      FETCH
FETCH
FETCH
FETCH
FETCH
                        61.
62
63.
64.
65.
                        66.
67.
68.
69.
                                     105 DO 106 I = 1, 16
                                                                                                                                                                     FETCH
FETCH
FETCH
FETCH
                                     J = MAP(1)

106 NOM(J) = SCS(I)

IF(KARC - 1) 107, 107, 108

107 NOM(B) = OTP(KARC) - TO
                                                                                                                                                                                     107 - 108
                        70.
                                                                                                                                                                      FETCH
FETCH
                                                                                                                                                                                    110-
                                             60 TO 110
6 CCT 72 G.01-44
```

72 73.	108 NOM(8) = QTP(KARC) - QTP(KARC - 1) 60 TO 110	:	FETCH FETCH	110-
74. 75. 76.	109 1F(KAAC .LE. JARC) 60 TO 102 IF(ISGN .GT. 0) 60 TO 105 GO TO 104		FETCH FETCH	105
77. 78. 79. 80. 81. 82. 63.	110 X = JARC LARC = JARC IF(15GN .GT. 0) LARC = JARC + 1 CALL READMS(9, ARCDA, 42, LARC) CALL FORCES RETURN END		FETCH FETCH FETCH FETCH FETCH FETCH FETCH	
	·			·
		,		

PRTRAN	MATH	CODE	E DESCRIPTION	STORA		SUBROUTINE US
SYMBOL	SYMBOL		- DEGGHII I IUM	BLOCK	FOC	SUBH CODE V
AR CDA	S _{ref}	1	Aerodynamic reference area (FT ²)	/ARCDAT/(1)	ARCIN I SREI BNDRY I ARCI CHECK I ARCI FETCH I ARCI SALVE I ARCI STATEF I SREI UT I SREI WRAPUP I ARCI
I NARK		1	Logical unit on which initial and converged arcs are stored. INARK = 11.	/GLOBAL/(95)	CHECK O INAF FETCH I INAF INAFC I INAF MARCH I INAF WRAPUP I INAF
NARC	N ₃	ľ	Number of subarcs in the problem.	/GLOBAL/(- 18)	
NO A	V	O	Relative velocity. (FT/SEC)	/D /(91)	•
0	^t o	•	Trajectory start time. (SEC)	/GLOBAL/(MRAPUP I V FETCH M TO INARC M TO TRAJIM I TO MRAPUP I TO
	x	o	The quasitime variable.	/D /(ALT I X BNDRY O X ERROR I X FETCH O X FORCES 1 X INARC M X HADAMS M X RKUTT1 M X RKUTT2 M X SALVE M X STATEF I X WRAPUP M TT

SUBRØUT I NE FØRCES

FORCES controls the calculation of all quantities needed by subroutine

```
FORCES
FORCES
FORCES
 1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
                    SUBROUTINE FORCES
         00000
                                           THIS ROUTINE CONTROLS THE COMPUTATION OF ALL QUANTITIES NEEDED TO COMPUTE THE APPLIED ACCELERATIONS ON THE VEHICLE.
               REAL MAGBY, MU, M, LY, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM
                                                                                                                                     JUL21
CNTRL
CNTRL
CNTRL
CNTRL
CNTRL
                                                                                                                                   DYNA
JUL21
AUG09
                                                                                                                                    FORCES
FORCES
FORCES
       С
                                                                                                                                                 101
58:
59.
60.
61.
                                                                                                                                    FORCES
62.
63.
64.
65.
            101 CALL STATEF
                                                                                                                                   FORCES
                  ARE THERE ANY APPLIED LOADS AT ALL
IF(KODE .EQ. 0) 60 TO 102
CALL CONTRL
IS THIS POWERED FLIGHT
IF(IPOW .GT. 0 .AND. J1 .NE. 4) CALL IMPULS
IS THIS THE LAST PT. OF SUBARC
                                                                                                                                   FORCES
FORCES
FORCES
        C
67.
68.
                                                                                                                                   JUL21
FORCES
                                                                                                                                   FORCES
FORCES
FORCES
69.
70.
            102 IF(KPT .EQ. NPTS) CALL ARCEN
                  RETURN
END
```

FORTRAN SYMBOL	MATH Symbol	CODE	DESCRIPTION	ST BLOCK	ORAGE K L	o C	SUBROU SUBR	CODE	
IARC	I	1 5 u l	barc number.	/CMTRL	. /(24)	MARCH OLTOSZ SALVE	MILLIALMINI	
1P0 W		I Pos	vered flag. IPOW = 0: No thrust and no base drag IPOW = 1: Thrust, but no base drag IPOW = 2: Thrust and base drag	/DYNA	// 1	39)	ARCIN	# 1 1] [
J1		I The	rust option flag. J1 = 1: Constant thrust; J1 = 2: Input vacuum thrust; J1 = 3: Powered total acceleration limit; J1 = 4: Air-breather engine.	/DYNA	/()	73)	APPLY ARCIN CONTRL FORCES NPLANE STATEF THROTL	F I I I	してしていてい
KODE		I Ste	rering vector flag KODE = 0: Free fall, $\alpha = \theta = 0$; KODE = 1: Both α and θ optimal; KODE = 2: α optimal and $\theta = 0$; KODE = 3: α nonoptimal and θ optimal; KODE = 4: Vertical rise or pitchover; KODE = 5: α nonoptimal and $\theta = 0$.	/DYNA	/(;	25)		0 M]]	KKKKKK
KPT		poi	subarc point number. KPT = 1 on the first nt of subarc, and KPT = NPTS on the last point the subarc.	/CNTRL	/(8)	BNDRY FORCES	0 1 0 1	KKKKKKK
NPTS		I The	total number of points in the subarc.	/CHTRL	Α :	19)	BNDRY FORCES INARC MAGIC	0 1 M 0 M	HMMMMM
x	x	I The	quasitime variable.	/D	/(AL4 BNDRY Error	10 10 10 10 10 10 10 10 10 10 10 10 10 1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

GJRV is a general matrix inversion routine.

	1. 2. 3. 4.	C B J R V	IN ALGOL. ACM JOURNALL FEB. 1962. FORTRAN BY RAGUSA. DIMERSION A(N, N), B(40), C(40), IP(40), IQ(40) IFRR=0	elka elka elka elka elka		
F	6. 7. 8. 9.	1001	00 140K=1,N PIVOT=0.0 00 120 1=K,N D0 2 J=K,N IF(ABS'(A(1,J))-ABS (PIVOT)) 2,2,1	GJRV GJRV GJRV GJRV	1-72	٠٦
	11. 12. 13.	1	PIVOT=A(I,J) IP(K)=I IQ(K)=J	EJRA EJRA EJRA		
	14. 15. 16.	2 120	CONTINUE CONTINUE IF(ABS (PIVOT)-EPSIL)100,100,3	GJRA GJBA GJBA	3-1	00-
	17.	3	1F(1P(K)-K)4,6,4	GJRV	E5°	'
	18. 19. 20. 21. 22.	5	DO 5 J=1 N IPX=IP(K) Z=A(IPX, J) A(IPX, J)=A(K, J) A(K, J)=Z	PALS PALS PALS PALS PALS		
	23.		1F(1Q(K)-K)7,9,7	GJRV	7-9	╡
	24. 25. 26. 27. 28.	7	DD 8 I=1,N IPX=10(K) Z=A(I,IPX) A(I,IPX)-A(I,K) A(I,K)=Z	GJRV VRLG VRLG VRLG SJRV		
4	29.	9	DO 13 J=1,N	GJRV	-	J
Ш	30.	10	1F(J-K)11,10,11 B(J)=1.0/PIVOT	VRL9_	10	۲"
	32. 33.	10	G(J)=1.0/P1401 G(J)=1.0 G0 T0 12	GJRV GJRV	12-7	
Ш	34. 35.	11	8(J)=-A(K, J)/PIVOT C(J)=A(J, K)	6JRV Valg		
Ш	36. 37. 38.	12	A(K,J)=0.0 A(J,K)=0.0 CONTINUE	VALS VALS VALS	-	
	39. 40. 41. 42.	14	00 14 1=1 N 00 14 1=1 N a(I_J)=a(I_J)+C(I)+B(J) CONTINUÉ	SJRV SJRV SJRV SJRV		
П	43. 44. 45.		DO 20 KP=1,N K=N+1-KP IF(IP(K)-K) 15,17,15	GJR4 GJR4 GJR4	15-	177
	46. 47. 48. 49.	15	DO 16 I=1,N IPX=IP(K) Z=A(I,IPX) A(I,IPX)=A(I,K)	VALA VALA VALA VALA		
П	50.	16	A(1,K)=Z IF(10(K)-K)18,20,18	GJRV GJRV	18-	20-
h	52. 53. 54.	18	IPX=1Q(K)' IPX=1Q(K)' Z=A(IPX,J)=A(K,J)	GJRV GJRV GJRV	لتتا	
14	55. 56.	19	A(IPX, J)=A(K, J) A(K, J)=Z	SJRV		_ }
4	57. 58.	20	CONTINUE GO TO 21	GJRV GJRV	21	
Į	59.		IERR=~1	6JRV		
	60.	21	RETURN END	VALS VALS		

SUBRØUT I NË I MPULS

500.

Purpose

IMPULS computes the rocket's specific impulse as a function of net thrust. In addition, it computes

$$\frac{\partial I_{sp}}{\partial T}$$
 and $\frac{\partial^2 I_{sp}}{\partial T^2}$

```
IMPULS
IMPULS
IMPULS
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
          1.
2.
3.
4.
5.
6.
7.
8.
                                                                                SUBROUTINE IMPULS
                             CCC
                                                                                                                                                                                THIS ROUTINE COMPUTES THE VACUUM SPECIFIC IMPULSE
                                                                        COMMON/ARCDAT/
*SREF EJ
*IATM IMOD
*XLMAX HDMA
*MAEB MAEC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 OTPI
GMAX
MAEA
MAEG
MWDB
                                                                                                                                                                                                                                                                                                          ,TMULT
,JPRO
,ALFMAX
,MAEE
,MZCG
                                                               **SREF 'E! XISP TMULT OTMC DTP!
**IATM 'HODE JAER JARN GMAX GMAX
**LMAX HOMAX GMDOT ALFMAX MACA
**ALMAX HOMAX GMDOT ALFMAX PHMAX MACA
**ALMAX HOMAX GMDOT MACA
**MISP MACC
**MISP MACC
**MISP MACA
**MISP MACC
**MISP MACA
**MIS
                                                                                                                                                    ,EJ
,IMODE
                                                                                                                                                                                                                                                                                                                                                                                    DINC
OMAX
PHMAX
MAEF
MWDA
ZE
REMAX
                                                                                                                                                                                                                              JAER
GMDOT
MAED
MXCG
ZCGR
RHOB
 ARCDAT
DYNA
DYNA -
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DYMA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DYNA
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DYNA
DYNA
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DYNA
DYNA
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DYNA
DYNA
DYNA
DYNA
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     AUGO9
IMPULS
IMPULS
IMPULS
 49.
501.
523.
554.
557.
558.
                          C
                                 C
                                                ISPFF = 0.

IF(JPRO .EQ. 2) 60 TO 100

MERE 1SP LOSSES INPUT

IF(MISP .LE. 0) RETURN

YES. COMPUTE ISP AND PARTS. W/RESP. TO THRUST

FOR = FYAC/FRATED

CALL SPLINE(MISP, FOR, CISP, CISPF, CISPFF)

50 ISP = CISPF*IRATED/FRATED

ISPFF = CISPF*IRATED/FRATED**2

RETURN

DUAL FROTOS
                                                                            ISP = XISP
ISPF = 0.
ISPFF = 0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IMPULS
IMPULS
IMPULS
JUL21
SEP15
IMPULS
IMPULS
IMPULS
IMPULS
                               С
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              100-
                             C
                                  ¢
 62.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IMPULS
63.
64.
65.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       JULZI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IMPULS
IMPULS
SEP15
JUL21
66.
67.
                                                                                                                                                                        DUAL ENGINE SIMULATION
                                  C
                                               DUML ENGINE STRULATION

100 FOR = FYAC/FRATED
CALL ISPRAT(FOR, CISP, CISPFF, CISPFF, 2)
GO TO 50
END
68.
69.
70.
71.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    JUL21
JUL21
JUL21
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IMPULS
```

FORTRAN SYMBOL	MATH Symbol	CODE	DESCRIPTION		STO BLOCK	ORAG	LOC	SUBRO:	TIN.	E VAR
311000	3711002				V			305		- 100
AE	A _{exit}	1 1	Total mozzie exit area	(FT ²)	/DYNA	/(89)	APPLY ARCIN IMPULS NLDRY TH2	SI	AE AE AE AE
FRATED		1 1	18 of the maximum rocket vacuum thrust	(LBS)	/DYNA	11	171)	ARCIN Impuls		FRATED FRATED
FVAC		A T	Total vacuum thrust (rocket)	(LBS)	/ DYNA	/(33)	APPLY ARCIN IMPULS NLORY STATEF TH2	SAI	FVAC FVAC FVAC FVAC FVAC FVAC
IRATED		-1 1	1% of the maximum rated I _{SP}	(SECS)	/DYNA	/(170)	ARCIN IMPULS	- 0	IRATED IRATED
ISP	¹ sp	0 ¥	Vecuum specific impulse	(SECS)	/DYMA	/(45)	APPLY ARCIN IRPULS		ISP ISP ISP
1SPF	∂1 _{\$P} /∂T	0 \$	See symbol .		/DYNA	/(179)	APPLY Impuls	I S 0	ISPF ISPF
ISPFF	8 ² 1 _{SP} /8T ²	0 \$	See symbol		/DYNA	/(180)	APPLY Impuls	5 O	ISPFF ISPFF
JPRO		I P	Propulsion model option flag		/ARCDAT	70	10)	ARCIN IMPULS	1 5 1	JPRO JPRO
MISP-		1 _C	Curve number kISP loss table		/ARCDAT		-26)	ARCIN Impuls		MISP
PA	P _a	I A	Atmospheric pressure	(LBS/FT ²)	/DYNA	/(IMPULS NLDRY OUTPUT TH2	I	PA PA PA PA
1	T		Thrust		/DYNA			ALGCOM AL1 AL4 AL6 AL7 AL8 AL9 APPLY ARCIM CONTRL DL2 IAPULS OUTPUT TH1 TH2 TH3 TH4	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	T T T T T T T T T T T T T T T T T T T
XISP	Isp	I V	Vacuum specific impulse	(SEC)	/ARCDAT	/(ARCIN IMPULS		XISP XISP

SUBRØUT I NE I NARC

INARC stores the initial arc on logical unit 12. The values stored are linearly interpolated from the initial arc file on logical unit 11.

```
SUBROUTINE IMARC
    1.
2.
4.
5.
6.
7.
10.
112.
113.
114.
120.
221.
223.
224.
225.
225.
227.
228.
331.
332.
333.
                                                                                                                                               INARC
            CCC
                                                 THIS ROUTINE STORES THE INITIAL ARC OUT ON UNIT 12.
                      INARC
                                                                                                                                               INARC
INARC
                                                                                                                                              BLOCK
                                                                                                                                              BLOCK
MAP
CNTRL
                                                                                                                                              CNTRL
CNTRL
CNTRL
                                                                                                                                               JUL21
                                                                                                                                             PC
PC
GLOBAL
GLOBAL
GLOBAL
                    GLOBAL
                                                                                                                                              INARC
INARC
                                                                                                                                              INARC
INARC
INARC
     34:
    38.
39.
40.
41.
42.
43.
                                                                                                                                              INARC
INARC
INARC
INARC
                MRITE(6, 1)
IERR = 0
REWIND INARK
REWIND 12
DO 105 I = 1, NUP
105 Y(1) = 0.
NARCTP = 1
                                                                                                                                              INARC
INARC
INARC
    45.
46.
47.
48.
49.
90.
                                                                                                                                              INARC
                                                                                                                                              INARC
INARC
INARC
d
                       READ IN TRAJ. START TIME, NUMBER OF ARCS AND ARC STAGING TIMES FROM 1ST RÉCORD.

READ(INARK) TOTAPE, NS, NARCTP, (GTAPE(IK), IK = 1, NARCTP)

IF(EOF, INARK) 101, 9
                                                                                                                                              INARC
                                                                                                                                                          9-101-
                                                                                                                                             INARC
    53.
                    9 WRITE(6, 5)
                                                                                                                                             INARC
                        MAKE SURE NUMBER OF ARCS AGREES WITH USER+S INPUT.

IF(NARCTP .NE. NARC) CALL ERROR(XINARC, -4, 1)

INITIALIZE TIMES
            C
                                                                                                                                             INARC
INARC
    95.
96.
97.
98.
99.
00.
            Ç
                                                                                                                                              INARC
INARC
INARC
                        TO = TOTAPE
TSTART = TO
                                                COMPUTE RECORD SIZE
            C
                                                                                                                                              INARC
                        NWRDS = 5 + 2*NS
KERR = 0
                                                                                                                                             INARC
INARC
INARC
INARC
                                                SET UP TRANSLATION MAP FROM STEEPEST DESC. STATE/COSTATE ORDERING TO OL ORDERING.
            ç
    63.
64. •
                 ILIM = NS + 1
DO 11 1 = 1 ILIM
K = I + MAP(I)
J = I + ILIM
IMAP(I) = K
11 IMAP(J) = K + MS
MOM = 0.
DO 40 IARC = 1 to
                                                                                                                                             INARC
INARC
                                                                                                                                             INARC
    . 66
                                                                                                                                             THARC
                                                                                                                                             INARC
INARC
                                                                                                                                             INARC
                                   IARC = 1 NARC
STORE NUMBER OF HOMOGENEOUS SOLUTIONS TO BE INTE-
GRATED OVER THIS ARC.
NOCCIARC)
                                                                                                                                             INARC
    13.
                       A0A =
                                                COMPUTE RECORD SIZE ON UNIT 12 OVER THIS ARC.
```

6 DCT 72 8.01-44

```
76.
77.
78.
79.
80.
81.
82.
83.
84.
                                       NN = N+(MOM + 1)

COMPUTE AND STORE TAU FOR THIS ARC
TAU = QTAPE(IARC)-TSTART
QT(IARC) = TAU
XARC = IARC
X = IARC - 1
COMPUTE AND STORE NUMBER OF RTS AN
                                                                                                                                                                                                                                             INARC
INARC
INARC
INARC
                     C
                                                                                                                                                                                                                                             INARC
                                                                                COMPUTE AND STORE NUMBER OF PTS. AND STEPSIZE FOR THIS ARC.
                                      THIS ARC.

DT = DELT(IARC)

NPTS = TAU/DT + 1.5

EPS = ABS(IAU - (MPTS - 1)*DT)

IF(EPS .GT. .5) NPTS = NPTS + 1

IF(NPTS .LT. 4) MPTS = 4

MPOINT(IARC) = NPTS

M = 1./FLOAT(MPTS - 1)

SET - 2

JET - 2
     84.
87.
88.
89.
40. C
     94.
95.
                           301 IF(KERR .EQ. 0) READ(INARK) (T(J), J = 1, NWRDS) IF(IT - IARC) 301, 303, 302
                                                                                                                                                                                                                                             INARC
                                                                                                                                                                                                                                                                   302 - 303 - 301 -
     96.
97.
98.
                           302 BACKSPACE INARK
BACKSPACE INARK
60 TO 301
                                                                                                                                                                                                                                             INARC
                         GO TO 301

303 MIN = NWRDS + 1

MAX = NWRDS + NWRDS

IF(KERR .EQ. 0) READ(INARK) (T(J), J = MIN, MAX)

TLAST = T(2)

TNEXT = T(NWRDS + 2)

DO 30 K = 1, NPTS

XX = X + 1. - XARC

TIME = TSTART + XX+TAU

IF(K .EQ. NPTS) TIME = TSTART + TAU

IF(KERR .EQ. 0) CALL MARCH(TIME, 1FT, T, NWRDS, KERR)

LFT = 3 - IFT

KK = 2 + NWRDS*(IFT - 1)

LL = 2 + NWRDS*(LFT - 1)

TLAST = T(LL)

TNEXT = T(KK)

12 DT = TNEXT - TLAST
                                                                                                                                                                                                                                             INARC
   99.
100.
                                                                                                                                                                                                                                             INARC
                                                                                                                                                                                                                                             INARC
                                                                                                                                                                                                                                             INARC
INARC
INARC
INARC
    101.
    102
   104. C
                                                                                                                                                                                                                                             INARC
INARC
INARC
INARC
   10.
   187:
   108.
  109.
110.
111.
112.
                                                                                                                                                                                                                                             INARC
INARC
INARC
                                                                                                                                                                                                                                                                   12-
                                                                                                                                                                                                                                             INARC
                                                                                                                                                                                                                                            INARC
INARC
INARC
  113.
 114.
116.
117.
118.
119.
120.
121.
                            12 DT = TMEXT - TLAST

FCTR = (TIME - TLAST)/DT

DO 20 I = 1 M

13 IF(I .ME. 10P) 60 TO 10

Y(I) = TAU

60 TO 20
                                                                                                                                                                                                                                             INARC
                                                                                                                                                                                                                                             INARC
INARC
                                                                                                                                                                                                                                                                   10-
                                                                                                                                                                                                                                             INARC
                            GO TO ZO

ID J = IMAP(I)

KK = J + NWRDS+(IFT - 1)

LL = J + NWRDS+(LFT - 1)

YA = T(LL)

IF(KERR .NE. 0) TO 20

DELY = T(KK) - YA

Y(I) = YA + FCTR+DELY
 122.
123.
124.
125.
126.
                                                                                                                                                                                                                                             INARC
                                                                                                                                                                                                                                            INARC
INARC
INARC
                                                                                                                                                                                                                                             INARC
                                                                                                                                                                                                                                                                  20
 127.
                                                                                                                                                                                                                                            INARC
INARC
                            20 CONTINUE
WRITE(12)(Y(IJ), IJ = 1, NN)
30 X = X + N
TSTART = TSTART + TAU
40 CONTINUE
RETURN
 129.
                                                                                                                                                                                                                                             INARC
 130.
131.
132.
                                                                                                                                                                                                                                            INARC
INARC
INARC
                                                                                                                                                                                                                                             IMARC
  134:
 135.
136.
137.
                          101 CALL ERROR(XINARC, -1, 1)
RETURN
                                                                                                                                                                                                                                            INARC
IMARC
```

ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	ST BLOC	OFA(LOC	SUBROU SUBR	COD	E USAGE E VAR
DELT		I	A twenty word array containing the quasitime compute interval for each subarc.	/D	/(211)	CHECK ERROR INARC	0 1 1	DELT DELT DELT
н	h	ĸ	Integration step size in quasitime.	/D	/(2)	AL4 INARC MADAMS RKUTT1 RKUTT2 SALVE WRAPUP	I M I I I	H H H H H DT
IARC			Subarc number.	/CNTRL	. 10	24)	ARCIN BCOND BNDRYPT CHECK BNDRYCHECK COSTAB COSTAB ENDPT FORCES INTRPT MAGICH QLTOSZ	1 m m 1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m 1	I ARCC I ARCC I ARCC I I ARCC
DP _	•	. 1	Component number that corresponds to the GL state variable v IDP = 8.	/PC	-νċ	.4.)	INARC	I I	I DP
NARK		1	Logical unit on which initial and converged arcs are stored. IMARK = 11.	/6L08A	L/(95)	CHECK FETCH INARC MARCH WRAPUP	0 I I I	I NARK I NARK I NARK I NARK I NARK
AP			An array that maps the initial arc state and costate into the QL state and costate.	/MAP	/(1)	CHECK INARC	D I	MAP MAP
0 m		Α.	The number of homogeneous solutions currently being integrated.	/CNTRL	/(9)	GROPE INARC LINDRY NOMNAL SALVE WRAPUP	A	MOM MOM MOM MOM MOM MOM
			Total number of QL state and costate variables. N = 18.	/PC	/(2)	SALVE	1	
AR C	N ₃	1 (Number of subarcs in the problem.	/GLOBA	L/(18)	BCOND BNDRY CHECK ENDPT ENVPRO FETCH IMARC MAGIC QLTOSZ SALVE WRAPUP	I	NARCC

FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION	STORAGE Block Loc	SUBROUTINE USAGE SUBR CODE VAR
NN		M The number of quantities currently being numerically integrated.	/CNTRL /(5.	2) BNDRY M NN INARC M NN MADAMS I NN MAGIC M NN NOMAL I NN RKUTTI I NN RKUTTI I NN RKUTTZ J NN SALVE M NN WRAPUP M NN
MGC		I An array containing a running total of the numbe of free (unknown) state and costate variables at the start of each subarc.		2) BNDRY I NOC BRANPT I NOC COSTAB O NOC COSTAI O MOC COSTAI O MOC COSTAQ O MOC INARC I MOC INTRPT I NOC SALVE I MOC MRAPUP I MOC
NPOINT		 A twenty word array containing the number of point ach subart. 	nts /D /(19	I) INARC O MPOINT SALVE I MPOINT
MPTS		M The total number of points in the subarc.	/CNTRL /(1'	P) BCOMD O MPTS BMBRY O MPTS FORCES I MPTS INARC M MPTS MAGIC O MPTS SALVE M MPTS MRAPUP_O MPTS
NUP -	·	1 Same as NU.	/CNTRL /(23	3) CHECK O NUP GROPE I NUP INARC I NUP
QT		O A twenty word array containing the values from t initial arc of the successive subarcs' durations		INARC O QT Wrapup m QT
TAU	7	M Subarc duration ·(S	EC) /D /(98) ARCEN I TAU INARC M TAU NLDRY : TAU OUTPUT I TAU STATEF I TAU
Т0	to	M Trajectory start time. (S	EC) /GLOBAL/(7	F) FETCH M TO INARC M TO TRAJIN I TO MRAPUP I TO
x	x	M The quasitime variable.	/D /{ 1	BADRY O X BADRY O X ERROR I X FETCH O X FORCES I X INATERP I X AADAMS M X RUUTTI M X RUUTTI M X SALVE M X STATEF I X WRAPUP M TT
Y		M An 820 mord array containing the particular and homogeneous solutions being integrated. The fir 18 mords comprise the particular solution. Each block of 18 mords thereafter comprises an independent homogeneous solution.	st) GROPE O Y INARC M Y MADAMS M Y OLTOSZ I Y RKUTTI M Y SALVE M Y WRAPUP I Y

SUBRØUT INE INTERP

INTERP interpolates the total solution from the preceding QL iteration at the midpoints of the first three compute intervals of each subarc. The results are used by the Runge-Kutta starting procedure.

```
SUBROUTINE INTERP

REAL MAGBY, MU, M, LY, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM
*LHT
COMMON /0/
*X, H, XI(4), MAGBY, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI,
*ALT_RHO, MU, M, TAU HT, LY LGAM, LPSI, LR, LRHO, LMU, LM, LTAU,
*LHT, D169, D110, BV(46), 2SAVE(20), Q1(26), NPOINT(26), DELT(26)
DIMENSION NOM(26)
EQUIVALENCE (NDM, Y)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      INTERP
                                     1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      วับเ21
D
D
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      INTERP
INTERP
INTERP
INTERP
                                                                                                                                                           THIS SUBROUTINE INTERPOLATES THE NOMINAL SOLUTION AT THE MID-
POINTS OF THE FIRST THREE COMPUTE INTERVALS. A FOURTH-ORDER ALT-
KENS ALGORITHM IS USED.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  INTERP -- LL
ZINTERP -- LL
ZINTERPRESE -- LL
ZIN
                                                                                                                                             19:
16:
17:
18:
19:
20:
21:
22:
                                                                                                                   DIMENSION P(20, 4)

NEWNOM = .TRUE.

D0 1 J = 1, 4

D0 1 I = 1, NNP

P(I, J) = ZI(I, J)

D0 2 K = 1, 3

S = XI(K) - X

L = K + 1

D0 2 J = L, 4

R = XI(J) - X

Q = R - S

U = R/Q

V = S/Q

D0 2 I = 1, NNP

2 P(I, J) = U+P(I, K) - V+P(I, J)

RETURN

END
                                 34567890123456789012
44567890123456789012
                                                                             C
```



FORTRAN Symbol	MATH SYMBOL	CODE	DESCRIPTION	BLOCI	ORAGE LOC	SUBROUTINE USAGE SUBR CODE VAR
NEWNOR		đ	A logical fing that indicates to the Runge-Kutta integration whether or not the system Jacobian needs to be reevaluated.	/CNTRL	/(15	INTERP O NEWNOM LINDRY M NEWNOM RKUTTI O NEWNOM SALVE O NEWNOM WRAPUP O NEWNOM WENOM
NNP		1	Number of QL state and costate variables.(18)	/CNTRL	/(22	CHECK A NNP INTERP I NNP
v	V		Relative velocity. (FT/SEC)	/0	. 91	AL1 I V AL4 I V AL4 I V AL5 I V AL6 I V AL9 I
	ж ~	i	The quasities variable.	/0	7(1)	BNDRY O X ERROR I X FORCES I X INARC M X INTERP I X RADAMS M X RKUTTI M X SALVE M X STATEF I X HRAPUP M TT
11			A four mord array containing the first four values of quasitime in the subarc.	/D	/(3)	INTERP I XI SALVE O XI
ı	Z	0	A 20 word array used to store the total linear solution from the preceding QL iteration.	/2	/(1)	BNDRY I Z BRANPT I Z ENDPT I Z ENDPT I Z INTERP O Z INTERP O Z INTERP I Z INTERP I Z OUTPUT I Z RKUTT1 O Z RKUTT2 M Z SALVE M Z RRANPUP M Z
Z1			A 20x4 array containing the first four values of Z in the present subarc.	/21	/(1)	INTERP I ZI RKUTTI I ZI SALVE M ZI



SUBRØUT I NE I NTRPT

INTRPT evaluates the state and costate target misses at an intermediate point and their partials with respect to the $c^{\dagger}s.^{\star}$

^{*}See Sections 16.6 and 17.4 of Vol. I.

```
INTRPT
INTRPT
INTRPT
INTRPT
INTRPT
INTRPT
                                      SUBROUTINE INTRPT(DPZIDC, KK)
        1...34...
9...
10...
112...
113...
113...
120...
                     00000
                                                                         THIS ROUTINE EVALUATES THE STATE AND COSTATE TARGET COND. MISSES AT AN INTERMEDIATE CORNER PT. IT ALSO EVALUATES THE PARTS.W/RESP.TO THE C+S OF THE MISSES.
                                   -REAL MAGBY, MU, M, LY, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM + LHT COMMON /D/
                                  JUL21
                                                                                                                                                                                                               D
CNTRL
GNTRL
CNTRL
CNTRL
CNTRL
CNTRL
GLOBAL
                                  COMMON/GLOBAL/
+GR , CR , OMGZ , XLAMRF, YMURF , LUM , TO , EPSLON, INNER
+ITRMAX, JUDPL6 , IFATAL, NARC , NBRAN , NFARC , ID(4) , KTAB(26),
+ITAB(26) , SIG, MAXTAB GM, PSIÁF , IPFLG1, IPFLG2, IPFLG3, IPFLG4,
+INEGFL(26) , ITPSO , KSOL , INARK , KGLOBAL(7)
COMMON /BLOCK/ IIC(10, 20) , IICT(10, 20) , ITC(10, 20) , JTAB(20),
+ITCT(10, 20) , LTAB(20) , NOKNOW, NOC(20) , VALIC(16, 20),
+VALTC(10, 20) , IPAY
COMMON /EVAL/ SGN, SPART(18) , MAP(10) , PZI(40) , NOCK , S(18, 41),
+TEMP(40) , DZ(18) , DC , L , SI(18, 41)
COMMON /Z/ Z(50)
DINENSION AI(18, 18) , BI(18) , DPZIDC(KK, KK) , VAL(18) , ZZ(18) ,
+TOM(18)
                                                                                                                                                                                                                 GLOBAL
GLOBAL
GLOBAL
         12.
13.
14.
15.
16.
17.
18.
19.
                                                                                                                                                                                                                BLOCK
BLOCK
BLOCK
                                                                                                                                                                                                                 INTRPT
                                  DIMENSION AI(18, 1

+ TOM(18)

DO 101 I = 1, 18

DO 101 J = 1, 18

AI(1, J) = 0

MA = 0

MTARG = JTAB(IARC)
        33.
34.
35.
36.
                                                                                                                                                                                                                 INTRPT
INTRPT
INTRPT
101
                                                                                                                                                                                                                 INTRPT
         37.
38.
39.
40.
                                                                                                                                                                                                                 INTRPT
                                                                                                                                                                                                                INTRPT
INTRPT
                                    MTARG = JTAB(IARC)
STORE THE NUMBER OF STATE AND COSTATE TARGET COND.
AT THIS PT.
NTARG = LTABLIARC)
ASSIGN 109 TO LABL
ARE THERE ANY COSTATE TARGETS.
IF(NTARG LE 0) 60 TO 109
YES. SET UP THOSE ROWS OF A1 MATRIX THAT RESULT
FROM THE INITIAL CONDS. ON STATE.
                   C
                                                                                                                                                                                                                 INTRPT
                                                                                                                                                                                                                INTRPT
INTRPT
INTRPT
        41.
42.
43.
44.
                   C
                                                                                                                                                                                                                 LATRPT
                                                                                                                                                                                                                                    109
                                                                                                                                                                                                                INTRPT
INTRPT
        47.
48.
49.
                          102 DO 108 I = 1, 9
IF(IIC(I, IAAC + 1) - 1) 103, 104, 105
CONTINUOUS STATE
                                                                                                                                                                                                                 INTRPT
                                                                                                                                                                                                                INTRPT
INTRPT
                                                                                                                                                                                                                                     103-104-105
                          103 MA = MA + 1
AI(MA, I) = 1
AI(MA, I + 9) = -1
GO TO 108
        50.
                                                                                                                                                                                                                INTRPT
        51.
52.
53.
54.
                                                                                                                                                                                                                                                                            108-
                                                                       KNOWN STATE
                                                                                                                                                                                                                 INTRPT
                          104 MA = MA + 1
AI(MA, I) = 1
GO TO 108
        55.
56.
57.
                                                                                                                                                                                                                 INTRPT
                                                                                                                                                                                                                                                                            108
                         105 IF(IIC(I, IARC + 1) - 5) 108, 106, 107
KNOWN DROP WEIGHT
        58.
59.
                                                                                                                                                                                                                                    106-107-
                                                                                                                                                                                                                                                            108
                    C
                                                                                                                                                                                                                INTRPT
                        106 MA = MA + 1
AI(MA, I) = -1
AI(MA, I + 9) = 1
GO TO 108
                                                                                                                                                                                                                INTRPT
INTRPT
INTRPT
        60.
61.
        63.
                                                                                                                                                                                                                INTRPT
                         107 WPRO = GR*(ZSAVE(7) - M)
SIZING DROP WEIGHT
CALL WIDDRP(WPRO, WDRP, DWDRP, 3)
                                                                                                                                                                                                                INTRPT
INTRPT
INTRPT
        64.
65. C
                                    AI(MA, I) = -1
AI(MA, I + 9) = 1. - DWDRP
                                                                                                                                                                                                                INTRPT
        68.
                          108 CONTINUE
        69.
                                                                                                                                                                                                               INTRPT
        70.
71.
                                    60 TO LABL
                                                                       ARE THERE ANY STATE TARGET CONDITIONS
```

Sizing Interface (SIZIN) · 7

•

. .

.

```
109 IF(MTARG .LE. 0) GO TO 115

VES. ADD THOSE ROWS TO AT MATRIX THAT RESULT FROM STATE TARGET CONDS.
                                                                                                                                                                                                                                                                                                                         INTRPT
INTRPT
INTRPT
                                                  STATE TARGET CONDS.

DO 114 I = 1, MTARG

MA = MA + 1

K = L + I

KODE = ITC(I, IARC)

IF(KODE .GT. 11) GO TO 111

SIMPLE RELATIVE STATE MATCH

KODE = MAP(KODE)

AI(MA, KODE + 9) = 1

COMP. AND STORE TARGET MISS

PZI(K) = NOM(KODE) - VALTC(I, IARC)

STORE PARTIALS OF MISS

DO 110 J = 1, NOCK

DPZIDC(K, J) = S(KODE, J + 1)

GO TO 114

COMPLEX CONDITION ON STATE
                                                                                                                                                                                                                                                                                                                         INTRPT
INTRPT
INTRPT
         78.
79.
80.
81.
                                                                                                                                                                                                                                                                                                                         INTRPT
INTRPT
INTRPT
INTRPT
                                                                                                                                                                                                                                                                                                                         INTRPT
INTRPT
INTRPT
         84.
85.
                                                                                                                                                                                                                                                                                                                         THTRPT
         84:
                                                                                                                                                                                                                                                                                                                                                                           114-
         88.
                                                                                                                                                                                                                                                                                                                         INTRPT
                                  COMPLEX CONDITION ON STATE

CALL PDBCQL(KODE, VAL, SPART, RUMMY, 1, ISKIP)

DO 112 J = 1, 9

112 A(IMA, J + 9) = SPART(J)

COMP. AND STORE TARGET MISS

PZI(K) = VAL - VALTC(I IARC)

COMP. AND STORE PARTIALS OF TARGET MISS

CALL MATMLT(TEMP, SPART, S(1, 2), I, 18, NOCK)

DO 113 J = 1, NOCK

113 DPZIDC(K, J) = TEMP(J)
        90.
91.
92.
93.
                                                                                                                                                                                                                                                                                                                         INTRPT
                                                                                                                                                                                                                                                                                                                        INTRPT
                                                                                                                                                                                                                                                                                                                         INTRPT
                                                                                                                                                                                                                                                                                                                        INTRPT
INTRPT
INTRPT
         75.
96.
97.
78.
                                                                                                                                                                                                                                                                                                                         INTRPT
                                                                                                                                                                                                                                                                                                                        INTRPT
     100.
                                    114 CONTINUE
                                                                                                                                                                                                                                                                                                                       INTRPT
INTRPT
                                ARE THERE ANY COSTATE TARGETS

115 IF(NTARG .LE. 0) 6D TO 129

CALL BASIS(AI, MA, 18)

CALL BASIS(AI, MA, 18)

CALL BASIS(AI, MA, 18)

CALL BASIS(AI, MA, 18)

SET UP THE BI VECTOR.

KNOCK = NOC(IARC + 1)

CALL READRS(41, SI 18-(KNOCK + 1), 2*IARC * 1)

CALL MATRLT(2Z, SI(1, 2), C, 18, KNOCK, 1)

CALL MATADD(2Z, 2Z, DZ, 18, 1)

DO 116 I = 10, 18

BI(I - 9) = -2Z(I)

116 BI(I) = NOM(I)

IF(IPAY.EQ.9.AND..NOT.(NBRAN.LT.IARC.AND.IARC.LT.NFARC))
**AI(I7) = BI(I7) + 1.

IF = MA + 1

IL = 18 - MA

IP = L **ATARE

CALL MATRLT(VAL, BI AI(1, IF), I 18, IL)

STORE NON-TRIVIAL TRANS.CONDS. AS COSTATE TARGET
MISSES
     101.
                                                                                                          ARE THERE ANY COSTATE TARGETS
    102.
                                                                                                                                                                                                                                                                                                                        INTRPT
      103.
104.
105.
                            C
                                                                                                                                                                                                                                                                                                                        INTRPT
INTRPT
INTRPT
INTRPT
105.
106.
107.
108.
109.
110.
111.
112.
113.
                           C
                                                                                                                                                                                                                                                                                                                        INTRPT
INTRPT
                                                                                                                                                                                                                                                                                                                        IMTRPT
                                                                                                                                                                                                                                                                                                                         INTRPT
                                                                                                                                                                                                                                                                                                                        INTRPT
INTRPT
INTRPT
INTRPT
                                                                                                                                                                                                                                                                                                                        SEP15
SEP15
INTRPT
    114.
115.
116.
117.
119.
120.
121.
122.
123.
                                                                                                                                                                                                                                                                                                                        INTRPT
                                                                                                                                                                                                                                                                                                                        JATRPT
INTRPT
INTRPT
INTRPT
                          C
                                 MISSES

OU 117 I = 1, MTARG

K = IP + 1

J = ITCT(I, IARC)

11, PZ1(K) = VAL(J)

COMPUTE DIVIDED DIFF. PARTS.W/RESP.TO THE C*S OF THE COSTATE TARGET MISSES

DO 128 IC = 1, KMOCK

COMP. STATE/COSTATE PERT. THAT RESULTS FROM THE PERT.OF TMIS C. LATE SIDE

CALL MATMLT(DZ, S(1, IC + 1), DC, 18, 1, 1)

ADD STATE/COSTATE PERT. TO BASE VALUE. LATE SIDE.

CALL MATADDITOM, ZZ, DZ, 18, 1)

IF(IC - NOCK - 1) 118, 119, 1201

THIS C HAS AM EFFECT ON THE EARLY SIDE, SO COMP.

ITS EFFECT DN THE EARLY SIDE STATE/COSTATE VECTOR
                                                                                                                                                                                                                                                                                                                        INTRPT
INTRPT
INTRPT
     124.
                                                                                                                                                                                                                                                                                                                       INTRPT
INTRPT
INTRPT
INTRPT
                            C
       12/.
    12w.
12w.
130.
                                                                                                                                                                                                                                                                                                                       INTRPT
INTRPT
INTRPT
                            C
    131
   131.
132.
133.
134.
136.
                                                                                                                                                                                                                                                                                                                       INTRPT
INTRPT
INTRPT
                           C
                                                                                                                                                                                                                                                                                                                                                                      -119-1201
                                                                                                                                                                                                                                                                                                                        INTRPT
    138.
                                    118 CALL MATMLT(DZ, S(1, IC + 1), DC, 18, 1, 1)
CALL MATADD(NDM, Z, DZ, 18, 1)
                                                                                                                                                                                                                                                                                                                       INTRPT
     139.
140.
141.
                                                                                                                                                                                                                                                                                                                       INTRPT
INTRPT
INTRPT
                                                    CALL MATA
60 TO 120
                                                                                                          THIS C AND ALL SUBSEQUENT C+S IN THIS LOOP ARE NOT TO HAVE AN EFFECT ON THE EARLY SIDE, SO RESTORE THE EARLY SIDE STATE/COSTATE VECTOR TO ITS BASE VAL.
     142.
143.
```

6 DCT 72 8.01-44

		•		
	144. 119 DO 1191 T = 1, 18 145. 1191 NOM(I) = Z(I)	INTRPT		$\ $
	146. 120 CALL FORCES 147. C RECOMPUTE AI MATRIX	INTRPT		\parallel
<u>[</u>	150. 121 AI(I, J) = 0 151. MA = 0 152. ASSIGN 122 TO LABL 153. GO TO 102	INTRPT INTRPT INTRPT INTRPT INTRPT INTRPT		1
	124	INTRPT INTRPT INTRPT INTRPT INTRPT INTRPT INTRPT INTRPT	123	
	160. Al(MA, KODE + 9) = 1 160. SD TO 125 162. 123 IŠKIP = 0 163. CALL POBCOL(KODE, VAL, SPART, RUMMY, 1, ISKIP) 164. DO 124 J = 1, 9 165. 124 Al(MA, J + 9) = SPART(J)	INTRPT INTRPT INTRPT INTRPT INTRPT	125	
	166. 125 CONTINUE 167. 1251 CALL BASIS(AI, MA, 18) 168. CALL SJRV(AI, 18, 1.E-12, IERR) 169. C DO 126 I = 10, 18 170. DO 126 I = 10, 18 171. BI(I - 9) = -TOM(I)	INTRPT INTRPT INTRPT INTRPT INTRPT INTRPT INTRPT INTRPT		
	173,	SEP15 SEP15 INTRPT INTRPT INTRPT INTRPT INTRPT INTRPT		
L	100. K = 1P + 1 101. J = 1TCT(1 IARC) 101. 12, DPZ10C(K, 1C) = (VAL(J) - PZI(K))/DC 102. 12/ CONTINUE 103. 129 L = L + MTARG + NTARG	INTRPT INTRPT INTRPT		ا
	185. C UPDATE NUMBER OF STATE AND COSTATE TARGET MISSES 186. C COMPUTED SO FAR 187. RETURN 188. END	INTRPT INTRPT INTRPT INTRPT		
				~
~		- 1		

FORTRAN SYMBOL	MATH 5 y mbol	CODE	DESCRIPTION .	ST BLOC	ORAG	LOC	SUBROUTI SUBR CO	
c	¢	ĭ	A forty word array containing the vector of c's, i.e. the multipliers for the homogeneous solutions.	70	K	11)	BNDRY I BRANPT I GROPE I INTRPT I NEWCS M NLDRY I WRAPUP I	0000000
DC	Δc,	1	Small perturbation of a c.	/EVAL	/(867)	BNDRY D BRANPT I ENDPT I INTRPT I	DC DC DC DC
OZ	Δc ₁ h ₁ (1-)		An 18 word array that contains the second term on the right hand side of Equation 17.4-11 of Vol.I of this document.	/EVAL	/(849)	BRANPT I ENDPT I' INTRPT I	DI DI DI
GR	9 ,	1	Gravitational acceleration at surface of the earth. (FT/SEC ²)	/GLOBA	L/(1)	ALS APPLY I BRANPT I COSTAB I COSTAI I INTRPT I OUTPUT I OLTOSZ I SALVE I STATEF I	Gr Gr Gr Gr Gr Gr Gr Gr
IARC	1	ī	Subarc number.	/CNTRL	ĸ	24)	ARCIN I BCOND M BNDRY I CHECK M COSTAB I COSTAB I ENDPT I FORCES I INARC M INTRPT I MAGGIC M MARCH I SALVE M MARPUP M M M M M M M M M M M M M M M M M M	I ARC
110			A 10x20 array containing the initial condition codes for the QL state vector. The columns correspond to subarc starting points, the rows, to QL state variables.	/BLOCK	/(1)	BCOND M BRANPT I CHECK I COSTAB I COSTAI I COSTAO I INTRPT I SALVE I	11C 11C 11C 11C 11C 11C 11C
170			A 10x20 array containing the initial condition codes for the QL costate vector. The columns correspond to subarc starting points, the rows, to QL costate variables.	/BLOCK	K	401)	BCOND G BRANPT I CHECK I COSTAB I COSTAI I ENDPT I INTRPT I	11C 11C 11C 11C 11C 11C
ffct		. !	A 10x20 array containing the QL costate analog to the array IICT. The columns correspond to subarc end points. The nonzero entries in a column are the numbers of those components of the vector 8 in Equation 16.6-34 of Volume I of the PADS document that contain the value of a costate target condition that applies at the end of the corresponding subarc.	/BLOCK	/(621)	BCOND O BRANPT I CHECK I COSTAB O COSTAI O INTRPT I MAGIC O	11CT 11CT 11CT 11CT 11CT 11CT

FORTRAN Symbol	MATH Symbol	CODE DESCR	IPTION	STORAGE BLOCK LOC	SUBROUTINE USAGE SUBR CODE VAR
JTAB		I An array containing the nine school column of the arra	uber of nonzero entries y IICT.	/BLOCK /(601	BCOND M JTAB BRAMPT I JTAB CHECK I JTAB COSTAB I JTAB COSTAB I JTAB ENDPT I JTAB INTRPT I JTAB MAGIC I JTAB
L		M Total number of target cou problem.	nditions to satisfy in the	/EVAL /(868	BADRY M L BRANPT M L ENDPT M L INTRPT M L
LTAB		I An array containing the nutring in each column of the arra	imber of nonzero entries ly ITCT.	/BLOCK /(821	BCOND O LTAB BRANPT I LTAB COSTAB O LTAB COSTAI O LTAB INTRPT I LTAB MAGIC M LTAB
- -	•	î Mass	(6'S)	/D /(97	ALT I MALT I MAL
MAP		I A 10 word array that maps state vector into the QL s		/EVAL /(20)	BNDRY D MAP BRANPT I MAP ENOPT I MAP INTRPT I MAP
NBRAN	N,	I Number of the last subarc problem. If the problem i then NGRAM = 0.		/6L0BAL/(19	BNDRY I NBRAN BRANPT I NBRAN COSTAB I NBRAN ENYPRO I NBRAN INTRPT I NBRAN MAGIC I NBRAN QLTOSZ I NBPAN SALVE I NBRAN
NFARC	N ₂	I Number of the last subarc the problem is not a branc NARC.		/GLOBAL/(20)	BCOND I NFARC BNDRY I NFARC COSTAB I NFARC ENVPRO I NFARC HATRO I NFARC QLTOSZ I NFARC QLTOSZ I NFARC
NOC		1 An array containing a runn of free (unknown) state an the start of each subarc.	ing total of the number d costate variables at	/BLOCK /(842)	BNDRY I NOC BRANPT I NOC COSTAB O NOC COSTAI O NOC COSTAO D NOC INARC I NOC INTRPT I NOC INTRPT I NOC SALVE I NOC MRAPUP I NOC
NDCK	• t	I The number of c's in the v Equation 17.4-4 of Vol.i o	ector C _l defined by f this document.	/EVAL /(70)	BNDRY M NOCK BRANPT I NOCK ENDPT I NOCK INTRPT I NOCK

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FORTRAN SYMBOL	MATH Symbol	con	E DESCRIPTION	S1 BLOC	K	GE LOC	SUBROUTINE USAGE SUBR CODE VAR
NO M	v	A	Relative velocity. (FT/SEC		/(91)	ALI I V AL4 I V AL8 I V AL8 I V AL8 I V AL8 I V BCOND I NOM BNORNYT M NOM CONTRL I V ENDPT I NOM ENUPRO I V FETCH O NOM INTERPT M NOM NLDRV O NOM NLDRV I V OUTPUT I V POBCQL I V
PZI		R	A 40 word array that contains the target condition problem.	/EVAL	/(30)	STATEF I V WRAPUP I V BNDRY I PZI BRANPT M PZI ENDPT M PZI
\$		1	An 18x41 array used to store the particular and homogeneous solutions on the early side of a corner point.	/EVAL	11		INTRPT M PZI BNDRY I S BRANPT I S ENDPT I S
\$1		1	An 18x41 array used to store the particular and homogeneous solutions on the late side of a corner point.	/EVAL	/(BRANPT I SI INTRPT I SI
SPART		ı	An 18 word array whose first nine entries receive the values of the partial derivatives wrt the state of those target conditions computed in subroutine PDBCQL.	/EVAL	/(2)	BNDRY D SPART BRANPT I SPART ENDPT I SPART INTRPT I SPART
TEMP	(a* ₁ /ac ₁) ^T	I	A 40 mord array that contains the transpose of the vector defined by Equation 17.4-9 of Voi.1 of this document.	/EVAL	/(809)	BRANPT I TEMP ENDPT I TEMP INTRPT I TEMP
VALTC		I	A $10x20$ array containing the desired values of the state target conditions whose codes appear in the array IICT.	/BLOCK	/(1062)	BCOND O VALTC BRANPT I VALTC CHECK I VALTC ENDPT I VALTC INTRPT I VALTC
I	ı		A 20 mord array used to store the total linear solution from the preceding QL iteration.	/1	/(1)	BNDRY I Z BRANPT I Z ENOPT I Z ENOPT I Z INTERP O Z INTERP O Z INTERP I Z INTERP I Z INTERP I Z RUTPUT I Z RKUTTI O Z RKUTTI M Z SKUTTZ M Z SKRAPUP M Z
ZSAVE		1	A twenty word array containing the values from the initial arc of the state and costate at the initial point of the trajectory.	/D	/(151)	

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SUBRØUT I NE L I NDRV

LINDRV computes the quasitime derivatives of the particular and homogeneous solutions. These derivatives are defined by Equations 17.1-9 and 17.1-10 in Vol. I.

```
LINDRY
LINDRY
LINDRY
LINDRY
LINDRY
LINDRY
LINDRY
LINDRY
CONTRL
CONTRL
CONTRL
CONTRL
CONTRL
LINDRY
                                 SUBROUTINE LINDRY(Y, F)
 1.
2.
3.
4.
5.
67.
8.
10.
112.
134.
15.
16.
                                                                        THIS ROUTINE COMPUTES THE DERIVATIVES OF THE PARTICULAR AND HOMOGENEOUS SOLUTIONS
                            18.
19.
10.
11.
12.
13.
14.
15.
```

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44	
N	
>	U

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	ST BLOCK	DRAGE LOC	SUBROUTING SUBR CODE	
JAKE		ī	An 18x18 array defined by Equation 17.5-5 in Vol.I of this document. The entry in the 1-th row and j-th column is the total partial derivative of the quasitime derivative of the Y, component of Y with respect to the Y; component of Y, i.e., avi/avj, where V = (yT, \lambdaT)	/JACOB	/(1)	LINDRY I NLDRY M NLDRY M SALVE D	JAKE ADA Jacob Jake
MO M		1	The number of homogeneous solutions currently being integrated.	/CNTRL	/(9)	GROPE O INARC M LINDRY I NOMNAL I SALVE -M WRAPUP M	MOM MOM MOM MOM MOM MOM
N		ī	Total number of QL state and costate variables. N = 18.	/PC	/(2)	BNDRY I CHECK I INARC I LINDRY I NLDRY I NOMNAL I RKUTTI I SALVE I WRAPUP I	N N N N N N N
NEWNOM		n	A logical flag that indicates to the Runge-Kutta integration whether or not the system Jacobian needs, to be recveluated.	/CNTRL	/(15)	RKUTTL 0	NEWNO NEWNO NEWNO
Z	2	ı	A 20 mord array used to store the total linear solution from the preceding OL iteration.	/2	/(1)	BNDRY I BRANPT I ENDPT I ENVPRQ I INTERP I LINDRY I NOMNAL M OUTPUT I RKUTTI O RKUTTI O RKUTTI M WRAPUP M	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
20		1	A 20 mord array containing the vector $f(X,Z,M)$ in Equation 17.1-7 in Vol.1 of this document.	/20	/(1)		ZD ZD ZB ZD ZD

SUBRØUT I NE MADAMS

500

Purpose

MADAMS carries out the fourth order Adams-Moulton integration of the particular and homogeneous solutions.*

^{*}See Section 17.6 of Vol. I.

```
SUBROUTINE MADAMS
                                                                                                                                                                                                   MADAMS
          1.
2.
3.
4.
5.
7.
                                                                                                                                                                                                   MADAMS
MADAMS
MADAMS
MADAMS
                                                                    THIS ROUTINE CARRIES OUT THE FOURTH ORDER ADAMS-MOULTON INTEGRATION OF THE PARTICULAR AND HOMO-GENEOUS SOLUTIONS
                              MADAMS
MADAMS
CNTRL
CNTRL
CNTRL
CNTRL
CNTRL
GLOBAL
GLOBAL
GLOBAL
GLOBAL
          B.
      14.
15.
16.
19.
20.
21.
22.
23.
24.
25.
                                                                                                                                                                                                   GLOBAL
D
                                                                                                                                                                                                   JUL21
      78901.2345
78901.2345
78901.2345
78901.234
78901.234
78901.234
                                                                                                                                                                                                  MADAMS
MADAMS
                                                                                                                                                                                                  MADAMS
MADAMS
MADAMS
                                                                   SET SCALING FACTORS AND INITIALIZE PREDICTOR AND CORRECTOR
                                                                                                                                                                                                  MADAMS
                                                                                                                                                                                                  MADAMS
MADAMS
MADAMS
                            HP = H/24.

HC = H/720.

00 1 I = 1, NN

YP(1) = Y(1)

1 YC(1) = Y(1)
                                                                                                                                                                                                  MADAMS
                                                                                                                                                                                                  MADAMS
MADAMS
MADAMS
                           1 YC(1) = YCI,

00 2 K = 1, 9
L = INDX(K)
TP = HP+P(K)
TC = HC+CC(K)
DD 2 I = 1, NM
FIL = F(I, L)
YP(I) = YP(I) + TP+FIL
2 YC(I) = YC(I) + TC+FIL
INCREMENT INDEP. VAR. AND ADD LAST TERM TO CORR.
                 ε
                                                                                                                                                                                                  MADAMS
                                                                                                                                                                                                  MADAMS
MADAMS
       44.
45.
                                                                                                                                                                                                  MADAMS
                                                                                                                                                                                                  MADAMS
                                                                                                                                                                                                  MADAMS
MADAMS
      46.
46.
49.
50.
51.
52.
                                                                                                                                                                                                  PADAMS
                           X = X + N

CALL LINDRY(YP, F1)

TC = HC+CC(5)

BO 3 I = 1, NN

3 YC(1) = YC(1) + TC+F1(1)

J = 1

MORE INNER
                                                                                                                                                                                                  MADAMS
MADAMS
MADAMS
MADAMS
                                                                                                                                                                                                  MADAMS
MADAMS
d
      24.
                                                                                                                                                                                                  MADAMS
                                                                 MORE INNER LOOPS.
      38:
                                                                                                                                                                                                  MADAMS
                           # IF(J .GE. INNER) GO TO 4

YES. MAKE PRED. = CORR. AND UPDATE CORR.

CALL LINDRY(YC, F2)

DO 5 1 = 1, NN

YP(1) = YC(1)

YC(1) = YC(1) + TC*(F2(1) - F1(1))

5 F1(1) = F2(1)

J = J + 1

GO TO 4

ROTATE INDEX POINTERS AND SET INTEGRAL = (
      57.
58.
59.
                                                                                                                                                                                                 MADAMS
                                                                                                                                                                                                 MADAMS
MADAMS
                                                                                                                                                                                                 MADAMS
MADAMS
MADAMS
MADAMS
      62.
63.
64.
                                                                                                                                                                                                 MADAMS
MADAMS
      6> .
                                                                  ROTATE INDEX POINTERS AND SET INTEGRAL = CORR.
                                                                                                                                                                                                 MADAMS
     67.
68.
69.
70.
                           6 ISAVE = INDX(1)
INDX(1) = INDX(2)
INDX(2) = INDX(2)
INDX(3) = INDX(4)
INDX(4) = ISAVE
DD 8 I = 1, MM
8 Y(1) = YC(1)
                                                                                                                                                                                                 MADAMS
                                                                                                                                                                                                 MADAMS
MADAMS
MADAMS
MADAMS
MADAMS
MADAMS
                                 CALL LINDRY(Y, F(1, ISAVE))
                                                                                                                                                                                                 MADAMS
```

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MADAMS MADAMS 75. 76. RETURN END

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FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOCK	PAGE LOC		SUBROU SUBR		USAGE VAR
							·····		
F		I 6 k 1	on 820x4 array used to store the vectors 1, k ₂ , k ₃ , and k ₄ defined by Equations 7.6-7 thru -10 of Vol.1 of this document.	/F	/(MADAMS Salve		F F
F1		m A	in 820x4 array used to store the vectors k ₁ , k ₂ , 3, and k ₄ defined by Equations 17.6-2 thru -5 in ol.1 of this document.	/STUFF	/(- 1	MADAMS RKUTT1 RKUTT1	I	F1 FK FS
н	h	· I I	ntegration step size in quasitime.	/0	/(;	1	AL4 INARC MADAMS RKUTT1 RKUTT2 SALVE WRAPUP	i M	H H H H H DT
INDX		M 0	n array of four mords that indicate to Adams- ouiton integration in mhat order the derivatives f the particular and homogeneous solutions are tored.	/CNTRL	/(1	•	BCOND Madams Salve	F 6	I NDX I NDX I NDX
INNER		I N	umber of Adams-Moulton inner loops.	/6L08AL	./(!		CHECK PADAMS	Ā	I MMER
A.N			he number of quantities currently being umerically integrated.	/CNTRL	/(52	1 P P A	NDRY INARC MADAMS MAGIC NOMNAL IKUTTI	M I I	
• • • •	-	-	• • •		٠	S	IBUTTZ ALVE IRAPUP	M	NN _ NN NN
x	` x	и т	he quasitime varimbie.	/D ,	/(1	F F I I R R S S	NDRY RROR ETCH ORCES NARC	M I M M M M M M M I	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Y		h: 1	n 820 mord array containing the particular and omogeneous solutions being integrated. The first 8 mords comprise the particular solution. Each lock of 18 mords thereafter comprises an independent homogeneous solution.	/¥	/(1	I F Q R S	ROPE NARC IADAMS LTOSZ KUTTI ALVE IRAPUP	RIR	A A A A

MAG computes the magnitude of a vector \mathbf{v} drawn from the Euclidean space $\mathbf{E}^{\mathbf{n}}$. This magnitude is defined as

$$||v|| = \sum_{i=1}^{n} |v_i|.$$

MAG

```
FUNCTION MAG(V, N)
REAL MAG
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
                                                                                                                                   CCCC
                   THIS SUBPROGRAM COMPUTES THE SCALER MAGNITUDE OF THE VECTOR V.
                   DIMENSION V(N)
               SUM = 0.

DO 1 I = 1, N

1 SUM = SUM + ABS(V(1))

MAG = SUM

RETURN

END
```



SUBRØUTINE MAGIC

MAGIC controls the determination of the costate initial and target conditions over all of the corner points in the problem.*

^{*}See Sections 16.6, 17.1 and 17.2.

```
MAGGICC
MAGGICC
MAGGICC
CNTTRL
CNTTRL
CNTTRL
BLOCK
BLOCK
BLOCK
BLOCK
BLOCK
BLOCK
                                                   SUBROUTINE MAGIC
        1. 23. 4. 5. 67. 89.
                     0000
                                                                                                              THIS ROUTINE CONTROLS THE BETERMINATION OF THE COSTATE INITIAL AND TARGET CONDITIONS.
                                           10.
11.
12.
13.
14.
15.
                                                                                                                                                                                                                                                                                                                                          GLOBALL
GLOBAL
GLOBAC
HAGGIC
MAGGIC
M
17.
18.
19.
10.
12.
123.
145.
17.
18.
                           OATA MAGIX / DINITIALIZE ....

DO 101 I = 1, 9

DO 101 J = 1, NARC

ITCT(1, J) = 0

101 IICT(1, J) = 2

DO 101 I = 1, NARC

101 IICT(8, I) = 1

SET INTEGRATION CONTROL FLAGS SO THAT FORCES WILL WILL CALL ARCEN AND ARCIN.
                     C
                    ç.
                                               NPTS = 1
KPT = 1
DO 104 IARC = 1, NARC
CLEAR LTAB ENTRY.
   30.
31.
32.
                   C
                                                 LTAB(IARC) = 0

IS THIS THE FIRST ARC

IF(IARC .GT. 1) GO TO 102

YES. INITIAL POINT.
                     C
   35 .
36 .
                                                                                                                                                                                                                                                                                                                                                                             102-
                   C
   37.
30.
39.
                                                 CALL COSTAO
GO TO 104
                                                                                                                                                                                                                                                                                                                                                                                                    104
                                                                                                             IS THIS THE FIRST ARC OF THE FIRST BRANCH.
                               102 IF(IARC .NE. NBRAM + 1) GO TO 103
YES. BRANCH POINT.
   41.
42.
43.
                                                                                                                                                                                                                                                                                                                                           MAGIC
MAGIC
MAGIC
                                                                                                                                                                                                                                                                                                                                                                             103
                                                 CALL COSTAB
60 TO 104
                                                                                                                                                                                                                                                                                                                                                                                                    104
                                                                                                                                                                                                                                                                                                                                           MAGIC
MAGIC
                                                                                                             15 THIS THE FIRST ARC OF THE SECOND BRANCH
                                                                                                                                                                                                                                                                                                                                           MAGIC
MAGIC
MAGIC
                              103 IF(1ARC .EQ. NFARC + 1) 60 TO 104
NO. INTERMEDIATE POINT.
   46.
47. C
                                                                                                                                                                                                                                                                                                                                                                             104
                                                 CALL COSTAI
 49.
50.
51.
52.
53.
                                                                                                                                                                                                                                                                                                                                          MAGIC
MAGIC
MAGIC
MAGIC
MAGIC
                                 104 CONTINUE
                                                                                                            COMPUTE TOTAL NUMBER OF STATE AND COSTATE TARGET CONDITIONS TO MATCH
                                                CONDITIONS TO MA

NCOND = 9

IF(NFARC .LT, MARC) NCOND = 18

NN = NARC - 1

DO 105 IARC = 1, NN

IF(IARC .EQ. NFARC) GO TO 105
                                                                                                                                                                                                                                                                                                                                           MAGIC
MAGIC
  >> .
                                                                                                                                                                                                                                                                                                                                                                         105
                              105 NCOND = NCOND + JTAB(IARC) + LTAB(IARC)

MAKE SURE NUMBER OF TARGETS EQUALS NUMBER OF

UNKNOWN INITIAL VALUES.

IF(NCOND - NOKNOW) 116, 118, 117
 57.
58.
59.
60.
                                                                                                                                                                                                                                                                                                                                           MAGIC
                                                                                                                                                                                                                                                                                                                                           MAGIC
MAGIC
                               116 CALL ERROR (MAGIX, -1, 1)
                                                                                                                                                                                                                                                                                                                                           MAGIC
61.
 62
                                117 CALL ERROR(MAGIX, -2, 1)
                                                                                                                                                                                                                                                                                                                                           MAGIC
                                118 RETURN
                                                                                                                                                                                                                                                                                                                                           MAGIC
MAGIC
 63.
64.
                                                END
```



FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION	STORAGE BLOCK LOC	SUBROUTINE USAGE
IARC	1	M Subarc number.	/CNTRL /(24)	ARCIN I IARC BCOND M IARC BNORY M IARC BRANPT I IARC COSTAB I IARC COSTAB I IARC COSTAB I IARC ENDPT I IARC FORCES I IARC INARC M IARC INTRPT I IARC MAGIC M IARC MAGIC M IARC QLTOSZ I IARC QLTOSZ I IARC SALVE M IARC MRAPUP M IARC
1167		O A 10x20 array containing the target condition code for the state vector. The columns correspond to the subarc end points. The nonzero entries in a column are the state target condition codes that apply at the end of the corresponding subarc.	es /BLOCK /(201)	CHECK I LICT COSTAB M 11CT COSTAI M 11CT COSTAO O 11CT MAGIC O 11CT SALVE I 11CT
ITCT		O A 10x20 array containing the QL costate analog to the array IICT. The columns correspond to subarc end points. The nonzero entries in a column are the numbers of those components of the vector 8 is Equation 16.6-34 of Volume I of the PADS document that contain the value of a costate target condition that applies at the end of the corresponding subarc.		BCOND O ITCT BRANPT I ITCT CHECK I ITCT COSTAB O ITCT COSTAI O ITCT INTRPT I ITCT MAGGIC O ITCT
JTAB		I An array containing the number of nonzero entries in each column of the array IICT.	/BLOCK /(601)	BCOND M JTAB BRANPT I JTAB CHECK I JTAB COSTAB I JTAB COSTAI I JTAB ENDPT I JTAB INTRPT I JTAB MAGIC I JTAB
KPT		O The subarc point number. KPT = 1 on the first point of subarc, and KPT = NPTS on the last point of the subarc.	/CNTRL /(8)	BCOND O KPT BNDRY O KPT FORCES 1 KPT MAGIC O KPT RKUTT1 I KPT SALVE M KPT WRAPUP M KPT
LTAB		M An array containing the number of nonzero entries in each column of the array ITCT.	/BLOCK /(821)	BCOND O LTAB BRANPT I LTAB COSTAB O LTAB COSTAI O LTAB INTRPT I LTAB MAGIC M LTAB
NAR C	N ₃	I Number of subarcs in the problem.	/GLOBAL/(18)	BCOND I MARC BNDRY I MARC CHECK I MARC ENDPT I MARC ENUPRO I MARC FETCH J MARC INARC I MARC MAGIC I MARC QLTOSZ I MARC SALVE I MARC WRAPUP I NARC
M A R 8 <i>V</i>	N ₁	1 Number of the last subarc on the stem of a branch problem. If the problem is not a branch problem, then NBRAN = 0.	/GLOBAL/(19)	BNDRY I MBRAM BRANPT I MBRAM COSTAB I MBRAM ENVPRO I MBRAM INTRPT I MBRAM MAGIC I MBRAM OLTOSZ I MBRAM SALVE I MBRAM

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FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORA(BLOCK	LOC	SUBROUTINE SUBR CODE	
NFARC	N ₂	I	Number of the last subarc on the first branch. If the problem is not a branch problem, then NFARC = NARC.	/GLOBAL/(20)	BCOND I BNDRY I BRANPT I COSTAB I ENVPRO I INTRPT I MAGIC I QLTOSZ I SALVE I	NF ARC NF ARC NF ARC NF ARC NF ARC NF ARC
		Я	The number of quantities currently being numerically integrated.	/CNTRL /(52)	BNDRY M INARC M MADAMS I MAGIC M NOMNAL I RKUTTI I RKUTTZ I SALVE M WRAPUP M	NN NN NN NN NN NN NN NN
ROKNOW			The total number of free (unknown) state and costate variables over all the subarcs.	/BLOCK /(841)	GROPE I	NO K NO W NO K NO W NO K NO W NO K NO W NO K NO W
NPTS -	- ·		The total number of points in the subarc.	/CNTRL /(BNDRY O FORCES I INARC M MAGIC O SALVE M	NPTS NPTS NPTS NPTS NPTS NPTS NPTS



SUBRØUT INE MARCH



 $\mbox{\it MARCH}$ finds the closest two points on the initial arc file that bracket the desired interpolation time.

```
SUBROUTINE MARCHITIME, IFT, T, NWRDS, 1ERR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          MARCH
MARCH
MARCH
MARCH
MARCH
MARCH
MARTHL
CNTRL
CNTR
              2.
3.
4.
5.
6.
7.
8.
                                                                                                                                                                                                                             THIS ROUTINE FINDS THE CLOSEST TWO PTS. ON THE INITIAL ARC FILE THAT BRACKET THE DESIRED INTER-POLATION TIME.
                                                           10.
11.
12.
13.
14.
15.
16.
17.
18.
20.
21.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          MARCH
MARCH
MARCH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 101-103-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       MARCH
MARCH
MARCH
MARCH
MARCH
MARCH
MARCH
MARCH
23.
24.
25.
26.
27.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 102
   18.
19.
                                                               102 IF(T(2, IFT) .LT. TIME) 60 TO 100 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        MARCH
MARCH
 31.
32.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             100
                                                                  103 IERR = 1
RETURM
 33.
34.
35.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          MARCH
MARCH
MARCH
```



FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORAG BLOCK	LOC	SUBROU SUBR	CODE	USAGI VAR
I ARC			number.	/CNTRL /(24)	BCOND BNDRY BRANPY CHECK COSTAB ENDPT FORCES INARC INTRPT MAGIC MARCH QLTOSZ		I ARC I ARC
INARK		l Logical are sto	unit on which initial and cenverged arred. INARK = 11.	cs /GLOBAL/(95)	CHECK FETCH INARC MARCH WRAPUP	I I I	INARK INARK INARK INARK INARK

6 OCT 72 6.01-44

MATADD performs the matrix addition

S = A + B,

where S, A and B are n x m matrices.

```
MATADD MATADD
                             SUBROUTINE MATADD(S, A, B, M, M)
1.
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12.
                            THIS ROUTINE PERFORMS THE MATRIX ADDITION S=a+B, WHERE N IS THE NUMBER OF ROWS IN THE A (B) MATRIX AND M IS THE NUMBER OF COLUMNS IN THE A (B) MATRIX.
                            DIMENSION A(1), B(1), S(1)
                       J = N+M

DO 1 I = 1, J

1 5(I) = A(I) + B(I)

RETURN

END
```

SUBRØUTINE MØMECØ

100

Purpose

MOME(3) computes the aerodynamic moment coefficient $\mathbf{C}_{m}.$ It also computes the partial derivatives

$$\frac{\partial C_m}{\partial \alpha}$$
, $\frac{\partial C_m}{\partial M}$, $\frac{\partial^2 C_m}{\partial \alpha^2}$, $\frac{\partial^2 C_m}{\partial M^2}$ and $\frac{\partial^2 C_m}{\partial \alpha \partial M}$

```
MOMECO
MOMECO
                                                                                                                                                                                                                                                           SUBROUTINE MOMECO
                               1. 2. 4567.89.
                                                                                                                       0000
                                                                                                                                                                                                       THIS ROUTINE COMPUTES THE MOMENT COEFFICIENT AND ITS PARTIALS

LOGICAL SWITCH, ILDAD
REAL MACH, ISP, ISPY, ISPR, ISPM, ISPT, ISPVV, ISPVR, ISPVM,
**ISPVT, ISPRR, ISPRR, ISPRR, ISPMT, ISPMT, ISPTT, LIFT, LIFTY,
**LIFTR, LIFTY, LIFTVR, LIFTVR, LIFTVR, LIFTRR, LIFTRR, MUR, LIFTRA,
**ITRATED, ISPFF, ISPFF,
**REAL MACHY, MACHRA MACHRA MACHRA MEAL LIFTW, LIFTVR, LIFTVR, LIFTVR, LIFTVR, LIFTVR,
**COSA, DYNOI1, DMEGAT, TAMP, PA, RO,
**LIFTV, LIFTW, LIFTVA, LIFTYA, L
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      THIS ROUTINE COMPUTES THE MOMENT COEFFICIENT AND ITS PARTIALS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    MOMECO
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```

6 BCT 72 6.01-44

- 1

FORTRAN Symbol	MATH Symbol	CDD	DESCRIPTION		BLOC	ORAG	LOC	SUBROUT SUBR C	INE USAGE
ALPHA	a	ī	Angle of attack	(RAD)	/ DYNA	/(79)	AEROCO ALGCON AL2 ARCIN CONTRL ENVPRO MOMECO MPLANE OUTPUT TRAJIN UT	M ALPHA I ALPHA M ALPHA I ALPHA
CM	C,	0	Homent coefficient		/DYNA	/(122)	MOMECO (CM C
CMA	C.	1	Moment coefficient slope	(RAD-1)	/DYNA	/(123)	MOMECO !	
CMAA	3C _{#€} /3α	0	See symbol		/DYNA	/(125)	MOMECO (
CMAM	ac _{me} /am	I	See symbol		/DYMA	/(1273	MOMECO I	1 CMAM
CMAMM	a ² C/am ²	ı	See symbol		/BY#A	/(131)	MOMECO STATEF	
CMM	ac_/am	_ 0	See symbol	•	/DYNA	<u>''_</u>	124)	MOMECO (
CARM	a ² C _a /am ²	0	See symbol		/DYNA	/(126)	MORECO C	
CM0	c.	1	Homent coefficient at $\alpha=0$.		/DVNA	/(128)	MOMECO I	CMO
CMOM	ac _{eo} /am	1	See symbol		/DYNA	/(129)	MOMECO I	
CMOMM	a ² C _{a0} /am²	ı	See symbol .	,	/DYNA	/(130)	MOMECO I	

SUBRØUT I NE NEWCS

NEWCS controls the Newton-Raphson iteration for the c's.*

^{*}See Section 17.4 of Vol. I.

```
SUBROUTINE NEWCS(DO, K)
         1.
2.
3.
4.
5.
6.
7.
8.
9.
                                                                                                                                                                                                               NEWCS
                                                                                                                                                                                                              NEWCS
NEWCS
NEWCS
NEWCS
NEWCS
CNTRL
CNTRL
CNTRL
                   0000
                                                            THIS ROUTINE CONTROLS THE DETERMINATION OF THE VALUES OF THE C+S THAT CAUSE ZERO TARGET CONDS. MISS.
                               11.
                                                                                                                                                                                                               CNTRL
                                                                                                                                                                                                               JUL21
         18.
        221234567890123456789
                                                                                                                                                                                                             # FORMAT(1M , 3ME= , 5E15.7)

WRITE(6, 1)

CLEAR C VECTOR, DIVERGENCE COUNTER AND CONVERGENCE FLAG.

SET CURRENT ERROR METRIC TO LARGE NUMBER.

DO 101 I = 1, K

101 C(I) = 0

101 V = 0

DLCBAR = 1.E3B

KOM = 0

START ITERATION

DO 105 IT = 1, 25

CLEAR PARTIAL MATRIX

DO 102 I = 1, K

102 D0(I, J) = 0

EVAL. TARBET MISSES AND PARTS. W/RESP. TO C=S.

CALL BNDRY(PZI, DO, K)

SAVE LAST ERROR METRIC AND COMP. NEW ONE.

DLPBAR = DLCBAR

DLCBAR = MAG(PZI K)/MAGBY

ARE WE CONVERGED

IF(DLCBAR.GT. ERR) 60 TO 1021

YES. SET COMY. FLAG
                   C
                                                                                                                                                                                                             NEWCS
NEWCS
NEWCS
NEWCS
NEWCS
                   C
                   C
日
        40.
41.
42.
43.
                                                                                                                                                                                                              NEWCS
                   C
                                                                                                                                                                                                              NEWCS
                                                                                                                                                                                                             NEWCS
NEWCS
                   C
        45.
46.
47.
48.
50.
                                                                                                                                                                                                              MENCS
                                                                                                                                                                                                             NEWCS
                                                                                                                                                                                                                                  1021-
                                                                                                                                                                                                              NEWCS
                    C
                                   NEWCS
                     1021 IFCDLCBAR .LE. DLPBAR) GO TO 103
C YES. INCREMENT DIVERGENCE COUNTER
10IV = 1DIV + 1
C HAVE ME ACCUMULATED 5 DIVERGENCES
1F(1DIV .EQ. 5) CALL ERROR(XNEMCS, -1,0)
C CONVERGING. DECREMENT DIVERGENCE COUNTER
        53.
54.
55.
                                                                                                                                                                                                                                 103-
                                                                                                                                                                                                             NEWCS
                                                                                                                                                                                                             NEWCS
                   C
                                                                                                                                                                                                             NEWCS
NEWCS
       56.
       >7.
                                                                                                                                                                                                             NEWCS
NEWCS
                          103 IDIV = MAXO(O, 1DIV - 1)
INVERT PARTIALS MATRIX
                                                                                                                                                                                                             NEWCS
NEWCS
        61.
                        104 CALL SJAV(DO, K, 1.E-12 IERR)

ARKÉ SURE INVERSION OK.

IF(IERR .NE. 0) CALL ERROR(XMEMCS, -2, 1)

UPDATE C VECTOR

CALL MATMIT(DELC, DO, PZI, K, K, 1)

CALL MATSUB(C, C, DELC(K, 1)

IF(KON .NE. 0) 60 TO 110

105 CONTINUE

RAN OUT OF ITERATIONS SHAP
        62.
                                                                                                                                                                                                             NEWCS
                                                                                                                                                                                                             NEWCS
NEWCS
NEWCS
                  C
        64.
65.
        66.
                                                                                                                                                                                                             NEWCS
                                                                                                                                                                                                             NEWCS
NEWCS
        67.
       68.
69.
/0.
                                   RAN OUT OF ITERATIONS. SHALL WE CALL IT CONVERGED ANYMAY.

IF(IDIV .NE. 0) CALL ERROR(XNEWCS, -3, 0)
                                                                                                                                                                                                             NEWCS
                                                                                                                                                                                                            NEWCS
NEWCS
NEWCS
                         110 WRITE(6, 2)
                                                                                                                                                                                                             NEWCS
```



	74 75. 76. 77.	WRITE(6, 3) (C(IJ), IJ = 1, K) WRITE(6,4) (PZI(IJ), IJ = 1, K) RETURN END	NEWCS NEWCS NEWCS NEWCS
, ; AFE'9.		•	
and the second s		· · ·	•
		V	
	•		The second second

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	S1 BLOC	n P A (LOC	SUBROL SUBR		
c	c	Ħ	A forty word array containing the vector of c's, i.e. the multipliers for the homogeneous solutions.	/0	K	11)	BNDRY BRANPT GROPE INTRPT NEWCS NLDRY NOTMAL	1 1 M 1	00000000
ERR		1	Convergence criterion of iteration for the c's.	/D	/(8)	CHECK		ERR ERR
MAGBY		I	The magnitude of all of the desired values of the state target conditions.	/0	/(7)	CHECK		MAGB Magb



SUBRØUT I NE NLDRV

Purpose

NLDRV evaluates the nonlinear state and costate quasitime derivatives. In addition, if the QL iteration is not converged, it also evaluates the system Jacobian.*

^{*}See Sections 16.6 and 17.5 of Vol. I.

С	SUBROUTINE NLDRV(Z,	ZD)				NI Ni
00000	STATE Compu	DERIVATIVE TES THE PAR	S. IF OL Tials of T	NONLINEAR STA IS NOT CONVER HESE EQUATION . THE JACOBIA	GED, IT ALSO S W/RESP, TO	NI NI NI
Ľ.	COMMON/ARCDAT/	v 1 . c o	74.0.7	2400		NI AF
	*SREF ,EJ *IATM ,IMODE	,XISP ,JAER	,TMULT ,JPRO	,DTNC ,OMAX	, OTPI	, Al
	*XLMAX , MUMAX #MAFR MAFR	, GMDOT , MAED	,ALFMAX MAFE	,PHMAX MAFF	,MAEA MAFG	AI
	401 , TA+	MXCG	A/66	MWDA ZE	MAIIN	, Al
	*MDB ,XCGR *DREF ,MCND	ZCGR ,RHOB	,XE ,QMULT	, REMAX	,XT ,FRATE	AF
	DREF , ACBN DIMENSION ARCDA(40 EQUIVALENCE(SREF, AR) - CDA)				AF
C	REAL SACOR					NI
	# LOTĂ LVTAH	, LATAU,	LURC, LUI	RCT, LUTVRC,	LGTV,	N
	# LPTCGV, LPTCG	AUP	MDR, I	980, MBM,	MDT,	N.
	* LVD. LGD	. LPD.	LAD, LVDR, LV	106, LM6,	LTD, LGDP,	N.
	* MD, LVDG, * LGDA, LGDO * LRDR, LRDO	, LGDT,	1 1 1 1 1 1 1 1 1 1 1	'UM IPBU	LPDT.	NI
	. ■ L6DM. LPDM	LRDA.	LUUM. LI	SDG. LADA.	LVDM, LMDT,	N L
	# LTDT, MOLV	, LYDLY, E	.GDLV, LMI .GDLG. LRI	JLG, LMULV,	LTDLY,	N:
	# MDLP # " MDLM	. LYULP. I	.GDLP, LRC .GDLM, ERC	DLP, LMDLP, HLM, LMDLM,	LTDLP, LTDLM	ML
	DCAL					ai.
	*LGDV,LTDG,LTDG,LKDV *LTDV,LTDG,LTDP,LTDR	,LKD6,LKDP,L	.UDV,LUU6,L .VDLH,LRDL1	.ODP,LODK,LMO 1.LTOLH.	Y,LMU6,LMUH,	N.
	*LPOLV,LODLV,LPOLG,L	DDLG, ĹPDLP, L VDLU 1 GDLU 1	ODLP LVDLF	I,LGDLR,LTDLR	,,4010,16010,	NL
	*LGOV,LPDV,LPDG,LRDV *LTDV,LTDG,LTDP,LTDR *LPDLV,LDDLV,LPDLG,L *LPDLO,LRDLO,LTDLO,L DIMENSION Z(16),ZDC	16)	,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		NL
	*AUA CUA BUA	BOV ODV	1104	MAY TAY	HTDV	N
	*LVDV ,LGDV ,LPDV	RDS ODS		LHUY LIUY	LHIDA ,	ML
	*LVD6 ,LGD6 ,LPD6	RDP OOP		LMDG LTDG	LHTDG ;	NL
						NL
	**************************************	, HUK , UUK	אעט,	LADR LIDE	, HIDH ,	NL
_	#VDU ,600 1200	, 6800 , 600	10 ,000	, MUU , IUU . MBB . I BB	, NIDO ,	NL
•	*YOU .60U .POU	K1341 13433		MOU TOU	HTDu	NL
	*LVDU ,LGDU ,LPDU *VDM ,GDM ,PDM	RDM LOO		, LMDU , LTDU , MDM , TDM	HTDM ,	NL
	*LVUM ,LGDM ,LVUM	ROT DOI	UBT	ADT TOT	HIDT .	NI.
	*LVDT LGDT LPDT *VDH GDH PDH	RDH ODH		, LADT , LTDT	, LHTDT ,	NL
	LADH (FDH (FDH COWNON / TOOR)	LEDH LOD	H 'FUDH	LADA LTDA	, CHTBH	N.
	ANDIN ADIN POIN	,RDLV ,ODL	V ,UDLV	MOLY ,TOLY	HTDLY ,	NL
	*LYDLV LGDLV LPDLV *VDLG GDLG PDLG	RDLG ODL		MOLG TOLC	, LHIDLY,	NL
					LHTOLG,	NL
	*VDLP GDLP PDLP *LVDLP LGDLP LPDLP	ROLP OOL	IP LUBLE			NL
	#VOLK , BULK , PULK	ROLR OOL	R JUDER	, AULK , IULK		NL
	#WOLO GOLU POLO	RAIA ANI	0 1101.0	WOTO EDTU	MIDIO	ML
	*LV0L0 ,LG0L0 ,LP0L0	RDIN ODL	u luotu	MOLU TOLU	, HTDLU,	NL NL
	*LVDLO ,LGDLO ,LPDLO	ROLM ODL		, LMDLU , LTDLI , MDLM , TDLM		NL
	*LVOLM EBOLM LPOLM	IRRIM ING	IM LUULM	imilim i liti i		NL
	*VULT LEDLT PULT	LADLI .COL	LT LUULT	MOLT TOLT	HTDLT,	NL
	*ADTH 'EDTH 'EDTH	ROLH ODL	H ,UDLH	, MDLH , TOLH	HTDLH	NL

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*EAPO
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, AGUV
, APZV
, AMGG
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*AGRV
*APUV
*AMZV
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APUG
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AGOP
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AGMG
APVP
AMPP
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APGR
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*AGOG
*APMG
*AMVP
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142.
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, AVOP
, AGMP
, APVR
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+AGUP
+APZP
                                                                                                             AVRP AGRP
AGUP APUP
APZP AMZP
COMMON /AXLE/
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, APUR
, AMZR
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, AMUR
, AVVD
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, AVMR
, AGVD
                                                                                                       *AMGR
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APZR
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150.
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*APVO AMVO AVGO AGGO APGO
*AMPO AVRO AGRO APRO AMRO
*AVVU AGUO APUO AMVO AVWO
*AGZO APZO AMZO AMVU AGVU
*AFGU APZO AMZO AMVU AGVU
*AFGU APZO AMZO AMVU AGVU
*AFGU APZO AMZO ARVU AGPU APPU
*AMMU AVOU AGOU APOU AMOU
*AVMU AGMU APMU AVGM AGGM
*APPM AMPM AVRM AGRM APRM
*ARPM AMPM AVRM AGRM APRM
*ARPM AMPM AGUM APMU AVVZ
*AGGZ APGZ AMGZ AVPZ AGGZ
*AMUZ AVMZ AGGZ APMZ AMMZ
*COMMON /AXLE/
*ARVLY AGGV APLV AMALV AVGM
*ARRLY AVOLY AGGLY APMZ
*ARRLY AVOLY AGGLY APVLY AGGVLY
*ARRLY AVGU AMVLO AVGLY AGGLY
*ARRLY AVGU AFGLY APVLY
*AGGY APVLG AMVLG ARVLY
*AGGY APVLG AMVLG AGGLG
*AVIG AGVLY
*ARRLY AVGU AGGLY APGLY
*ARRLY AVGLY AGGLY APGLY
*ARRLY AVGLY AGGLY APGLY
*ARRLY AGGLY APPLY ARGLY
*ARRLY AGGLY APVLC AGGLG
*AVULG AGVLY
*ARGLA AGGLG APZLG ARVLG AGGLG
*AVGLG AGVLG AFGLG APZLG AVVLP
*ARGLP APGLP AMGLP AFGLF AVVLP
*ARGLP APGLP AMGLP AFGLP APOLP
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167.
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APVLV V

APVLV V

APGZLG

APGLLG

APVLP

APVLP

APVLP
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AMVELLEG
AMVELLEG
AMVOMLLP
AMVOMLLP
AMVOMLP
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AVSLY ASSLY
APRLY
APPLLY
APPLLY
APPLLY
AVVLG
AVPLG
ASOLG
APMLG
AMMLD
AVGLP
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179.
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181.
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NLDRY
NLDRY
NLDRY
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NLDRY
NLDRY
NLDRY
                                                                                  C
                                                                                                                                                ASF1(A,B) = LMTAU*A + LVTAU*B
ASF2(C,D) = LGAM*C + LPSI*D
                       183: c
                                                                                                                               DO 1 I = 1, M

1 NOMI 1)=2(I)

CALL FORCES

1F(KODE - EQ. KODES) GO TO 3

KODES = KODE

DO 2 I = 1, 18

DO 2 J = 1, 18

2 JACOB(I, J) = 0.
     di85
                       184.
190
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                   192.
193. C
194. C
195. C
                                                                                                                                   3 IF(KODE .NE. O) CALL APPLY
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NLDRY
NLDRY
                                                                                                                                                                                           EVALUATE INTERMEDIATE CONSTANTS
                                                                                                                                                CGV = CDSGAM * V
RCRHO = R * COSRHO
OM2RVC = OMEGA2 * R * COSRHO / V
ORVCOG = OM2RVC/COSGAM
OM2RCO = OMEGA2 * RCRHO
OM2RC = OMEGA2 * RCRHO
OM2R = OMEGA2*R
OM2CO = OMEGA2*COSRHO
                   19/.
199.
199.
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NLDRY
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NLDRY
NLDRY
NLDRY
                                                                                  C
                                                                                                                                                    V2 = V+V
R2 = R+R
60V = 6/V
VOR = V/R
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NLDRY
NLDRY
NLDRY
NLDRY
NLDRY
NLDRY
                                                                            C
                   209.
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212.
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219.
                                                                                                                                                    TAUV = TAU / V
                                                                                                                                              TAUV = TAU / V
TAUVAR = -TAUVAYR
TYRO = TAUVAYRCRHO
TAUCGV = TAUVCGV
LOTR = LAWATAU/R
LVTAU = LAWATAU
LURC = LAWATAU
LURC = LAWATAU
LURCT = LURCOTAU
LUTVRC = LURCOTAU
LOTVRC = LORMOTAU/V
LOTT = LPSI-TAU/CGV
LOTT = LPSI-TAU/COSGAM
LOTT = LRHOVV-TAU/R
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NLDRY
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NFDRA
NFDRA
           220.
221.
222.
223.
224. C
                                                                                                                                                  CGCP =-COSGAM-+ COSPSI----
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CGSP = COSGAM * SIMPSI
COCG = COSRHO * COSGAM
SOSG = SINRHO * SINGAM
COSG = COSRHO * SINGAM
PRO = SIMPSI * SINRHO
SPSOSG = SPSO * SINGAM
CPCO = COSPSI * SORGAM
CPCO = COSPSI * COSRHO
COSP = COSPSI * SIMPHO
PRO = COSPSI * SIMPHO
PRO = SIMPSI * SIMGAM
CPSG = COSPSI * SIMGAM
CPSG = COSPSI * SIMGAM
COSGAM * COSGAM
COZ = COSGAM * COSGAM
COZ = COSGAM * COSGAM
COZ = COSRHO * COSRHO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NLDRY
NLDRY
NLDRY
NLDRY
NLDRY
           226.
227.
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232.
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NLDRY
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NLDRY
         233.
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NLDRV
                                                                                                 SOCCO = SINRHO/COSRHO
CG2 = COSRHO+COSRHO
CG2 = COSRHO+COSRHO

EXPRES = SINRHO-SINGAM-COSPSI + COSRHO+COSGAM
EXPRES = COSRHO-SINGAM - CGCP+SINRHO
EXPRES = COSRHO-SINGAM - CGCP+SINRHO
EXPRES = CPSG+COSRHO - SINZRO-SINGAM
EXPRES = CPSG+COSRHO - SINZRO-SINGAM
EXPRES = COSRHO-CGCP + SINZRO-SINGAM
EXPRES = COSRHO-CGCP + SINZRO-SINGAM
EXPRES = COSRHO-CGCP + SINZRO-SINGAM

ASSUME FREE FALL COMP 1ST PARTS. W/RESP.TO STATE

OF ALL STATE EQS. EXCEPT GD AND PD.
HTOT = QMULT+17-600 - SQRT(RQ/RHOB)+(V/2600Q.)**3.15

RDV = TAU + SINGAM
ODV = (TAU/R) + CGCP
UDV = (TAU/R) + CGCP
UDV = (TAU/RHO) + CGSP
HTOV = TAU+HTOT*3.15/V
VOG = TAU+CCFV
UDV = TAU+HTOT*3.15/V
VOG = TAU+CCFV
UDV = TAU+HTOT*3.15/V
VOG = TAU+CCFV
UDV = TAU+HTOT*8.15/V
VOG = TAU+CCFV
UDV = TAU+HTOT*8.15/V
VOG = TAU-COMPACO-EXPRES - COSGAM*G)

RDG = TAU-COMPACO-EXPRES - COSGAM*G
UDP = TAU-COMPACO-EXPRES - COSGAM*G
UDT = CAU-COMPACO-EXPRES - COSGAM*G
UDT = CAU-COMPACO-EXPRES - COSGAM*G
UDT = CGSP + V/RCHO
UDT = CG
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246. C
247, C
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2/3. C
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                                                                                                                 ACCOUNT FOR APPLIED LOAD EFFECTS IN 1ST PARTS.
W/RESP. TO STATE OF STATE EQS.
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301.
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                                                          LGD =
LPD =
LRD =
LOD =
LMD =
LTD =
                                                                                                 -LV*VOG ~ LR*RDG - LRHO*ODG - LMU*UDG - LM*MDG

-LV*VOP - LRHO*ODP -LMU*UDP - LM*MDP

-LV*VOR - LRHO*COR - LMU*UDR - LM*MDR - LHT*HTDR

-LV*VDO -LMU*UDO - LM*MDO

-LV*VDM - LM*MDM

-LV*VDT - LGAM*GDT -LR*RDT - LRHO*ODT - LMU*UDT -LM*MDT

-LHT*HTDT
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NLDRY
                                                             60 TO 9000
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                                                                                                                              NOT VERT. RISE/PITCHOVER. STILL ASSUMING FREE
FALL, COMP. 1ST PARTS. W/RESP. TO STATE OF GD AND
                               C
                                                      FALL, COMP. 1ST PARTS. W/RESP. TO STATE OF 6D AND PD.

O GDV =TAUV * (COSGAM*(GOV +VOR) - OM2RVC*EXPRES)

PDV =(TAU*SPSO) * (COSGAM*RCRHO - DRVCOG/V)

GDG = TAUV*(PSYSOS*(GOVCOG/COSGAM - V/RCRHO) - CPCO*OMEGAT/CG2)

GDP = TAU * ( CPCO * OMEGAT - OM2RVC * SPSOSG)

PDP = TAU*(DMEGAT*COSP*SGOCG * CPSO*GNVCOG * CGCP*SOOCO*VOR)

GDR = TAU * ( EXPRES*OM2CO/V - COSGAM*(VOR/R + GH/V))

PDB = TAU*SPSO/R * (ON*COG*** CGV/RCRHO)

GDD = TAU*(EXPRS2*DM2R/V - DMEGAT*SPSO)

PDD = TAU*(DMEGAT*(CPSO*SGOCG * COSRND) * SINPSI*OM2R*COS2RO/CGV * CGSP*VOR/CO2)

GDT = OMEGAT*(SSP*** EXPRES*OM2RV * COSGAM*(VOR/R - GOV)

PDT = OMEGAT*(SINRHO - CPCO*SGOCG) * SPSO*(ORVCOG * CGV/RCRHO)

15 THIS FREE FALL

1F(KODE.NE.O) GO TO 2000

COMPUTE STATE AND COSTATE DERIVATIVES.

VD = TAU * VOT

GD = TAU * POT

TO = TAU * POT

TO = TAU * OUT

UD = TAU * OUT

UD = TAU * OUT

UD = TAU * UUT

MD = O.

HTO = O.

HTO = O.

HTO = O.

HTO = -LV*VDB - LGAM*GDA - LPSI*PDB - LR*RDG - LR*HO*ODG - LMU*UDG

LCD = -LV*VDB - LGAM*GDD - LPSI*PDB - LMU*UDD - LR*HO*ODG - LMU*UDG

LCD = -LV*VDB - LGAM*GDD - LPSI*PDB - LMU*UDD - LR*HO*ODG - LMU*UDG

LCD = -LV*VDD - LGAM*GDD - LPSI*PDB - LMU*UDD

LCD = O.

LTO = -LV*VDT - LGAM*GDT - LPSI*PDB - LMU*UDD

LCD = O.

LTO = -LV*VDT - LGAM*GDT - LPSI*PDT - LR*RDT - LR*HO*ODT - LMU*UDT

GO TO 9000
                                                                                                                             PD.
                                                                                                                                                                                                                                                                                                                                                                                        MLDRY
 313.
314.
315.
                                    1000
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NLDRY
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318.
319.
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322.
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   323.
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325. C
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NLDRY
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 327.
320.
329.
338.
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331.
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                         C
                                                          60 10 9000
                                                                                                                                                                                                                                                                                                                                                                                                                                                           9000
                            C NOT FREE FALL. LUMPOLE S...

2000 VD = TAU*(AV + VDT)
GD = TAU*(AV + GDT)
PD = TAU*(AP/ CGV + PDT)
RD = TAU*RDT
OD = TAU*DT
UD = TAU*DT
UD = TAU*DT
UD = TAU*DT

MD = TAU*AM
HTD = TAU*HTDT
C
IF(KODE .LT. 4) GO TO 3GGO
C
YES. ACCOUNT FOR APPLIED LOAD EFFECTS ON 1ST PARTS.
C
M/RESP. TO STATE OF STATE EQS.
                                                                                                                            NOT FREE FALL. COMPUTE STATE DERIVATIVES.
                                                                                                                                                                                                                                                                                                                                                                                        NLBRY
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NLDRY
NLDRY
NLDRY
NLDRY
39 0.

39 1.

39 2.

39 3.

39 4.

39 6.

39 6.

39 6.

39 6.

39 6.

39 6.

39 7.

39 8.

39 9.

30 0.

30 1.
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NLDRY
NLDRY
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                                                                                                                                                                                                                                                                                                                                                                                      NI DRY
                                                         W/RESI
VDM = AVV + TAU
VDM = AVM + TAUV
GDM = AGM + TAUV
GDM = APM + TAUCGV
MDV = AMV + TAU
MDM = AMM + TAU
MDM = AMM + TAU
MDT = AM + AMZ+TAU
                                                                                                                                                                                                                                                                                                                                                                                      NLDR V
                                                                                                                                                                                                                                                                                                                                                                                      NLBRY
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NLDRV
364:
365.
366.
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367.
369.
369.
370.
371.
372.
                                                         GDV = GDV + TAUY*(AGV-AG/V)
PDV = PDV + (APV-AP/V)* TAUGGV
PDG = PDB + TAUGGV*SGOCG*AP

VDR = VDR + AVR*TAU

DDR = GDR + AGR*TAUY
PDR = PDR + APR*TAUGGV
VDI = VDI + AV + AVZ*TAU
                                                                                                                                                                                                                                                                                                                                                                                      NLORY
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375.
376.
377. C
378.
379.
380.
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                                                                                                                                                                                                                                       NI DAY
 382:
  383.
384.
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NLDRY
NLDRY
 385.
386.
  307.
                 C - 60 TO 9000 ... COMPUTE COSTATE EQS. FOR OPTIMAL CONTROL
                                                                                                                                                                                                                                       NLDRY
 388.
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NLDRY
NLDRY
                                                                                                                                                                                                                                                                                9000
                   COMPUTE COSTATE EQS. FOR OPTIMAL CONTROL

3000 LVD = -LV*TAU*EAVV - LGAM*(GDV*TAUV*(EAGV*AG/V))

* -LPSI*(PDV*TAUCGV * (EAPV*APV*) - LR*RDV - LR*MO*ODV NLDRV

* -LMU*UDV - LM*EAMV*TAU - LM**+TDV

LSD = -LV*VDG - LGAM*GDG - LPSI*(PDG + TAUCGV*AP**SGCCG) NLDRV

* -LR*HOG - LR*HO*ODG - LMU*UDG

LPD = -LV*VDP - LGAM*GDP - LPSI*PDP - LR*HO*ODP - LMU*UDP NLDRV

LRD = -LV*(VDR + TAU*EAVR) - LGAM**GDR + TAUV*EAGR) NLDRV

* -LFSI*(PDR*TAUCGV*EAPR ) - LR*HO*ODR - LMU*UDR - LM**TAU*EAMRN NLDRV

LDD = -LV*VDD - LGAM*GDD - LPSI*PDD - LMU*UDR - LM**TAU*EAMRN NLDRV

LDD = -LV*VDD - LGAM*GDD - LPSI*PDD - LMU*UDR - LM**TAU*EAMRN NLDRV

LTD = -LV*(VDT + AV + TAU*EAPX) - LGAM*(GDT + (AG + TAU*EAGZ)/V) NLDRV

* -LPSI*(PDT + AV + TAU*EAPX) - LGAM*(GDT + (AG + TAU*EAGZ)/V) NLDRV

* -LPSI*(PDT + (AP + TAU*EAPX) - LR*RDT - LR*HO*ODT-LMU*UDT NLDRV

* -LM**(AM + TAU*EAMZ) - LT**HTDT

C ISQ CONVERGED

IF(KONVER) GD TO 9900

ND. OPTIMAL CONTROL IN EFFECT. COMPUTE 1ST PARTS. NLDRV

NLDRV

* -VDLV = -VDP

* -VDLV = -VDP
 392.
 393.
394.
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3%.
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                                                                                                                                                                                                                                     NLDRY
NLDRY
NLDRY
                                  LPDLY = -VDP
LODLY = -VDO
LPOLG = -GDP
LODLG = -GDO
LPOLP = -PDO
LVDLR = -RDY
LGDLR = -RDY
LTDLR = -RDT
                                                                                                                                                                                                                                      NLDRV
                                                                                                                                                                                                                                      NLDRY
                                                                                                                                                                                                                                     NLDRY
NLDRY
414.
416.
416.
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418.
419.
420.
                                                                                                                                                                                                                                     NLDRV
                                                                                                                                                                                                                                     ALDRY
NLDRY
                                  LTDLR = -RDT

LVDLO = -ODV

LGDLO = -ODF

LPDLO = -ODR

LTDLO = -ODT

LVDLU = -UDV

LGDLU = -UDV

LPDLU = -UDV
                                                                                                                                                                                                                                     NLDRY
                                                                                                                                                                                                                                     NLDRY
NLDRY
 422.
423.
423.
424.
424.
                                                                                                                                                                                                                                     ML DRE
                                                                                                                                                                                                                                     NLDRY
NLDRY
                                                                                                                                                                                                                                     NLDAY
 42 .
42/.
                                                         -UDR
-UD0
-UDT
                                  LADLU =
LODLU =
LTDLU =
                                                                                                                                                                                                                                     NLDRY
                                                                                                                                                                                                                                      NLDR
420.
424.
430.
431.
                                                            ASF1( AMVLV, AVVLV) - EAVV*TAU + LGTV*(AGLV/V - AGVLV) + LPTCGV*(APLV/V - APVLV)
                                                                                                                                                                                                                                     NLDRY
                                                                                                                                                                                                                                     NLDRY
NLDRY
NLDRY
               C
                                  LGDLV = -LPTCGV+APLV+SGOCG - VDG
433.
434.
435.
436.
                                                                                                                                                                                                                                     NLDRV
                                 LRDLV = ASF1( AMRLV, AVRLV) - EAVR*TAU - LGTV* AGRLV
* - LPTCGV* APRLV - VDR
                                                                                                                                                                                                                                     NLDRY
NLDRY
NLDRY
                C
                               LMDL4 = ASF1( ARML4, AVML4) - EAVM+TAU - LGT4+ ASML4
+ -LPTCG4+ APML4
                                                                                                                                                                                                                                     NLDRV
439:
440. C
                                  LTDLY = ASF1( AMZLY, AVZLY) - EAVZ+TAU~ LGTV+ AGZLY

- LPTCGV+ APZLY - VDT

- AV - LV+AVLY - LA+AMLY - LGAM+AGLY/Y - LPSI+APLY/CGV
                                                                                                                                                                                                                                     NLDRY
 441.
                                                                                                                                                                                                                                    MEDRA
MEDRA
MEDRA
MEDRA
MEDRA
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MEDRA
MEDRA
448.
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444.
                               LVDLG = ASF1( AMVLG, AVVLG) + LGTV+(AGLG/V - AGVL
+ LPTCGV+(APLG/V- APVLG) + TAUV+(AG/V - EAGV)
                                  LGDLG = -LPTCGV+APLG+SGOCG - GDG
```

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450.
451.
452. C
453.
454.
                                                                                  LRDL6 = ASF1( AMRLG, AVRLG) - LGTV* AGRLG ~ LPTCGV* APRLG
* - TAUV*EAGR - GOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NLDRY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NLDRY
NLDRY
NLDRY
                                                                                        LMDLG = ASF1( AMMLG, AVMLG) - LSTV* AGMLG - LPTCGV* APMLG
- TAUV*EAGM
                                                                                       LTDL6 = ASF1( AMZLG, AVZLG) - LGTV+ AGZLG - LPTCGV+ APZLG

- TAUV+EAGZ - LV+AVLG- LM+AMLG- (LGAM+AGLG + AG)/V

- LPSI+APLG/CGV - GDT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NLDRY
NLDRY
NLDRY
   496.

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NLDRY
NLDRY
                                                                                LVDLP = ASF1( AMVLP, AVVLP) + LSTV*(AGLP/V - AGVLP)

+ LPTCGV*(APLP/V - APVLP) + TAUCGV*(AP/V - EAPV) - PDV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NLDRV
NLDRV
NLDRV
NLDRV
                                                                                    LGDLP = - LPTCGY+APLP+SGOCG - TAUCGY+AP+SGOCG
                                                                                                                                                                                                                                                                                                                                                                                                                                    - PDS
                                                                               LRDLP = ASF1( AMRLP, AVRLP) - LGTV+ AGRLP - LPTCGV+ APRLP - PDR
+ TAUCGV+EAPR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NI DRY
                                                                                LMDLP = ASF1( AMMLP, AVMLP) - LGTV+ AGMLP - LPTCGV+ APMLP
+ TAUCGV+EAPM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NLDRY
                                                                               LTDLP = ASF1( AMZLP, AVZLP) - LGTV+ AGZLP - LPTCGV+ APZLP
- TAUCGV+EAPZ - LV+AVLP - LM+MLP - LGAM+AGLP/V
- LPSI+APLP/CGV -AP/CGV - PDT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ML DRY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NL DRV
NL DRV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NLDRV
                                                                                     LVDLM = -TAU+EARV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        AL DRV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NLDRY
NLDRY
                                                                                    LRDLM = -TAU-EAMR
                                       C LADLM = -TAUSEARM

C LTDLM = -TAUSEARZ - AM
LYDLH = -HTDM
LTOLH = -HTDM
LTOLH = -HTDM
LTOLH = -HTDM
C ACCOUNT FOR THE EFFECTS OF APPLIED LOADS ON THE
DOTAL IST PARTS. W/RESP. TO STATE OF STATE EQS.

3100 GDV = GDV + (TAUV )*(AGV - AGV)
VDG = VOG + AVG *TAU
GDG = GDG + AGG *TAUV
GDG = GDG + AGG *TAUV
PDG = PDG + TAUCGV*(AP*SGOCG + APG)
VDM = VDM + AVM *TAUV
GDM = GDM + AGM * TAUV
PDM = PDM + APPR-TAUCGV
VDT = VDT + AV + AVZ*TAU
GDT = GDT + (AGZ*TAU + AG)/V
PDT = PDT + (AFZ*TAU + AG)/V
PDT = PDT + (AFZ*TAU + AF)/CGV
VDV = AVV*TAU
MDV = AMV*TAU
MDV = AMV*TAU
MDV = AMV*TAU
GDM = AGM*TAUV
PDM = APM*TAUCGV
PDM = APM*TAUCCGV
PDM = APM*
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NLDRY
                                                                                     LADLM = -TAU+EARA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NLDRY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NLDRV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NLDRY
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NLDRY
NLDRY
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NLDR4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NLDRV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NLDRV
NLDRV
      509.
                                                                                CONTINUE
ZD( 1) = VD
ZD( 2) = GD
ZD( 3) = PD
ZD( 4) = RO
ZD( 5) = GD
ZD( 6) = MD
ZD( 7) = MD
ZD( 8) = 0
ZD( 9) = HTD
ZD( 10) = LYD
ZD( 13) = LPD
ZD( 13) = LPD
ZD( 15) = CD
ZD( 15) = O
.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      MLDAV
       510.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NLDRY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NLDRY
NLDRY
   >11.
    512
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      MLDRY
>13.

>14.

>1b.

>1c.

>1d.

>1d.

>1d.

>20.

>21.

>22.

>23.

>24.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NLDRY
NLDRY
NLDRY
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NLDRY
NLDRY
NLDRY
NLDRY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NLDRV
NLDRV
NLDRV
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```
ZD(16)= LMD
ZD(17)= LTD
ZD(18)= 0.
   525.
                                                                                                                                                                                                                                                                                       MI DRY
   526.
527.
528.
529.
                                                                                                                                                                                                                                                                                       NLDRY
NLDRY
NLDRY
                                            ZD(18)= 0.

IS QL CONVERGED.

IF(.NOT KONVER) GO TO 9001

COMPUTE AND STORE VELOCITY LOSS DERIVATIVES.

ZD(19) = FVAC/M+TAU

ZD(20) = (DRAG + DB+COSA)/M+TAU

ZD(21) = AE+PA+CODAE/M+TAU

ZD(22) = G+SIMGAM+TAU

ZD(23) = FVAC+(1. - CODAE)/M+TAU
                   C
                                                                                                                                                                                                                                                                                        MLDRY
                                                                                                                                                                                                                                                                                                                   9001
   530.
531.
                                                                                                                                                                                                                                                                                       NLBR V
NLBR V
   532.
533.
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                                                                                                                                                                                                                                                                                         NLDRY
   534.
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                                                                                                                                                                                                                                                                                       NLDRY
                                                                                                                                                                                                                                                                                      NLDRY
NLDRY
NLDRY
                                             RETURN
                                                                                             QL NOT CONVERGED. ASSUME FREE FALL AND COMPUTE 1ST
PARTS.W/RESP. TO STATE OF COSTATE EQS. DMITTING
TERMS WITH LGAM OR LPSI.
  > 34 .
540 .
                          TERMS WITH LGAM OR LPSI.

9001 LVDG = LOTR*CPSG - LR*TAU*COSGAM + LURCT*SPSG
LVDP = LOTR*CGSP - LURCT*CGCP
LVDR = (LOTR*CGCP + LURCT*CGSP)/R - LHT*3.15/V*HTDR
LVDO = -LURCT*CGSP*SOCCO
LVDT = -LRHO*CGCP/R - LR*SINGAM - LURC*CGSP
LGOG = LUTVRC*CGSP + LVTAU*(SINGAM*G - OMZRCO*EXPRS*
* LR*TAU*SINGAM*V + LOVTR*CGCP
                                                                                                                                                                                                                                                                                      AL DRY
  541.
542.
                                                                                                                                                                                                                                                                                       NLDR V
                                                                                                                                                                                                                                                                                       NLDRY
  543.
544.
                                                                                                                                                                                                                                                                                      NLDRY
NLDRY
NLDRY
                                                                                                                                                                                                                 EXPRS1)
   >4» .
546 .
547 .
                   C
                                                                                                                                                                                                                                                                                       NLDRY
                                            LGDP = LUTYRC*CPSG - LYTAU*OM2RCO*SPSOSG - LOYTR*SPSG
                                                                                                                                                                                                                                                                                     MLDRY
 347; C
550.
551.
                                          LGDR =-LUTYRC+SPSG/R + LYTAU+(EXPRES+OM2CO ~ GH+COSGAM) -
LOYTR+CPSG/R
                    C
  5>2.
                                          LGDD = LUTYRC+SPSOSG/CDSRHO + LYTAU+OM2R+EXPRS2
  >> 3.
                  C
                                          LGDT =LURC+V+SPSG -L
- LR+CGV
                                                                                                                                   -LV*(OM2RCO*EXPRES - COSGAM*G)
GV + LRHO*YOR*CPSG
 5>6. C
                                                                                                                                                                      #SINRHO +LOVTR)#CGCP
                                          LPDP = LUTVRC+CGSP+(LVTAU+OM2RCO
 >> 0.
>> 0.
                    C
                                           LPDR = LVTAU+0M2CO+COSGAM+SPSO + (LUTVRC+CGCP - LOVTR+CGSP)/R
                    c
 561.
                                           IPDO = LVTAU+OM2R+COS2RO+CGSP - LUTVRC+CGCP+SOOCO
 >+2.
>+3.
                   C
                                            LPDT = CGSP+(LRH0+VOR - LV+OM2RCO+SINRHO) - LURC+V+CGCP
                    C
 >*> .
                                           NLORAA
NLORAA
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NLORAA
NLORAA
NLORAA
 544
 386:
569.
                   C
                                          LROO = LUTYRC+CGSP+SINRHO/RCRHO - LYTAU+OMEGA2+EXPRS3
LROT = LURC+VOR+CGSP - LV+(OM2CO+EXPRS1 - GH+SINGAM)
+ LRHO+VOR+CGCP/R
570.
571.
572.
573.
574.
                    C
                                          LODO = - LUTYRC*CGSP*SOCCO*SOCCO - LYTAU*OM2R*2.*(COS2RO*5INGAR - SIN2RO*CGCP)
                                        SINZRO*CGCP)

LODT =-LURC*V*CGSP*SODCO + LV*OMZR*EXPRS3

IS THIS VERT RISE/PITCHOVER.

IF(KODE .NE. 4) GO TO 4000

YES. ACCOUNT FOR EFFECTS OF APPLIED LOADS ON 1ST
PARTS.W/RESP.TO STATE OF COSTATE EQS.

LVDV = ASFI(ARW, AVVV) - LHT*2.15/V*HTDV

LVDM = ASFI(ARW, AVVM)

LGDM = ASFI(ARM, AVFM)

LPDM = ASFI(ARM, AVFM)

LPDM = ASFI(ARM, AVFM)

LVDG = LVDG + ASFI(ARW, AVVM)

LVDG = LVDG + ASFI(ARW, AVVM)

LVDD = LVDD + ASFI(ARW, AVVM)

LVDD = LVDD + ASFI(ARW, AVVM)

LVDD = LVDD + ASFI(ARW, AVVM)

LVDT = LVDT + ASFI(ARW, AVVM)

LODG = LGDG + ASFI(ARW, AVVM)

LGDC = LGDD + ASFI(ARW, AVVM)

LGDC = LGDD + ASFI(ARGA, AVGC)

LGDC = LGDC + ASF
                    C
5/0 C
                                                                                                                                                                                                                                                                                     NLDRY
NLDRY
NLDRY
NLDRY
                                                                                                                                                                                                                                                                                                                  4000-
5/U.
5/9.
>00.
>01.
>02.
>03.
                                                                                                                                                                                                                                                                                      M. DEV
                                                                                                                                                                                                                                                                                     NLDRY
NLDRY
> 44 .
> 45 .
                                                                                                                                                                                                                                                                                      MLDRY
                                                                                                                                                                                                                                                                                     NLORY
387 :
588 .
                                                                                                                                                                                                                                                                                      NLBRV
589.
590.
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592.
593.
594.
596.
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NLDRY
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                                                                                                                                                                                                                                                                                     NLDRY
NLDRY
NLDRY
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                                                                                                                                                                                                                                                                                      NLDRY
NLDRY
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600.
601.
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603.
604.
                        LPDT = LPDT + ASF1(AMPZ, AVPZ) - LM+AMP - LV+AVP
                                                                                                                                                   NLORY
                                                                                                                                                  NLDRY
NLDRY
NLDRY
NLDRY
NLDRY
           С
                        LRDR = LRDR + ASF1(AMRR,AVRR)
LRDO = LRDO + ASF1(AMRO,AVRO)
LRDT = LRDT + ASF1(AMRZ,AVRZ)
  605.
                       LODD = LODD + ASF1(AMDD AVOD)
LODT = LODT + ASF1(AMDZ,AVOZ) - LM=AMD - LV=AVO
LMDM = ASF1(AMMA, AVMM)
LMDT = ASF1(AMMZ, AVMZ) - LM=AMM - LV=AVM
LTDT = ASF1(AMZZ, AVZZ) - 2.+(LM=AMZ + LV+AVZ)
                                                                                                                                                  NLDRY
NLDRY
JUL198
JUL198
JUL198
NLDRY
 606.
607.
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611.
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614.
            Ç
                                                                                                                                                   NLDRY
                                                                                                                                                                             5000-
                        60 TO 5000
                                                                                                                                                   NLDRY
                                                 NOT VERT.RISE/PITCHOVER. STILL ASSUMING FREE FALL,
ADD IN TERMS WITH LGAM AND LPSI TO THE 1ST PARTS.
W/RESP. TO STATE OF THE COSTATE EQS.
            C
                                                                                                                                                  NLDRY
 617.
              NLDRV
 618.
                                                                                                                                                  NLDRY
 610.
620.
                                                                                                                                                  MLDRY
                                                                                                                                                  NLDRY
NLDRY
NLDRY
NLDRY
620.
621.
622.
623.
624.
626.
626.
            C
                       LVDP = LVDP + TAU*ASF2((-DM2RVC*SPSOSG/Y)(CPSO*ORVCOG/Y
- CGCP*SINRHD/RCRHO))
                                                                                                                                                  NLDRY
NLDRY
NLDRY
NLDRY
            C
                       LVDR = LVDR + TAU*ASF2(EXPRES*DM2CO/V2 - COSGAM*(GH/V2 - 1./R2),
(SPSO*DM2CO/(CGV*V) + CGSP*SOCO/R2))
            C
620.
629.
630.
632.
632.
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636.
637.
                                                                                                                                                  NLDRY
NLDRY
NLDRY
                       LVDO = LVDO + TAU+ASF2(EXPRS2*0M2R/V2...
(COS2RO*5INPS1*0M2R/(CGV*V) - CGSP/(R*CO2)))
            C
                                                        ASF2((EXPRES+OM2RVC/V - COSGAM+(GOV/V + 1./R)), (SP50+(ORVCOG/V - COSGAM/RCRHO)))
                       LVOT = LVCT +
                                                                                                                                                  NLDRY
                                                                                                                                                  NLDRY
NLDRY
NLDRY
           C
                       LGDG = LGDG + TAU#ASF2((EXPRES+OM2RVC + COSGAM+(VOR - GOV)),
(2.*OMEGAT*CPCO*5&OCG/CG2 -
SPCO*(OM2RVC*(2./CG2 - 1.)/COSGAM -
CGY/RCRHO)))
                                                                                                                                                  NLDRY
NLDRY
NLDRY
                                                                                                                                                  NLDRY
                                                                                                                                                  NLDRY
NLDRY
           C
  640.
                               = LGDP + TAU+ASF2((OM2RYC+CGSP+SINRHO), (CP50+SINGAM + (Y/RCRHO-ORYCOG/COSbam) - OMEGAT+COSP/CG2))
 641.
642.
643.
           C
                                                                                                                                                  NLDRY
                                       LGDR + TAU*ASF2((EXPRS1*Om2CO/V - SINGAM*(VDR/R + GH/V)),
(-SPSOSG*(VOR/RCRHO + Om2CO/(CG2*V))))
                       LGOR =
                                                                                                                                                  MLDRY
649.
646.
647.
648.
649.
           3
                      LGDO = LGDO + TAU*ASF2(( - 0M2R*EXPRS3/Y),(SPS6*YOR/CO2 - (OMEGAT*CPSO + SPS6*0M2R*CO52RO/Y)/CG2))
                                                                                                                                                  NLDRY
NLDRY
NLDRY
NLDRY
NLDRY
           C
                                                           ASF2((OM2RVC+EXPRS) + SINGAM+(VOR - GOV)),
((OMEGAT+CPCO - SPSOSG+OM2RVC)/
CG2 + SPSOSG+V/RCRHO))
                       LEDT = LEDT +
 651.
           C
 6> 3.
                                                                                                                                                  NLDRY
NLDRY
NLDRY
 654 .
655 .
                       LPDP = LPDP + TAU+ASF2((OMEGAT+COSP+OM2RVC+CPSO+SINGAM),
(ORVCOG+SPSO - OMEGAT+CPCO+SGOCG +
CGV +SPSO/RCRHO))
657.
656.
654.
660.
661.
662.
           C
                                                                                                                                                  NLDRV
                      LPDR = LPDR + TAU+ASF2((OM2CO+SPSOSG/V),(CPSO+(COSGAM+VOR/RCRHO -
OM2CO/CGV)))
                                                                                                                                                  NLDRY
NLDRY
           C
                                                                                                                                                  NLDRY
                      LPDO = LPDO + TAU+ASF2((OMEGAT+CPSO + SPSG*COS2RO+DM2R/Y),
(OMEGAT+SPSOSG/COSGAM - COSPS1+OM2R+
COS2RO/CGY - CGCP+VOR/CO2))
                                                                                                                                                  NLDRY
                                                                                                                                                  NLDRY
NLDRY
664.
667.
666.
661.
668.
670.
671.
672.
673.
                                                                                                                                                  ALDRY
           C
                                                        ASF2((OM2RVC+SPSOSG - DMEGAT+CPCO),
-(OMEGAT+COSP+SGOCG + CPSO+ORVCOG +
CGCP+SOOCO+VOR))
                      LPDT = LPDT +
                                                                                                                                                  MLDRY
                                                                                                                                                  NLDRY
NLDRY
           ç
                                                                                                                                                  NLBRY
                                                                                                                                                  NLDRY
                      LRDR = LRDR + TAU+ASF2((COSGAM*(GRR/V-2.*YOR/R2)), (-2.*CGV*SPSO/(RCRHO*R2)))
                                                                                                                                                  NLDRY
NLDRY
           C
                       LRDO = LRDO + TAU+ASF2(-EXPRS2+OMEGA2/V ,(CGSP+V/(RCRHO+RCRHO) ~
```

```
675.
676. C
677.
678.
                                                       SIMPSI+COS2RO+OREGA2/CGV))
                                                                                                                            NLDRY
                                                                                                                            NLDRV
NLDRV
NLDRV
                                               ASF2((COSGAM*(YOR/R + GH/Y) - EXPRES*OM2CO/Y),
(SPSO*(CGY/(RCRHO*R) - OM2CO/CGY)))
                   LRDT = LRDT +
679.
680.
681.
682.
683.
684.
                                                                                                                            MLDRY
                                                                                                                            MLDRV
                   NLDRY
                                                                                                                            MLDRY
                                                                                                                            NLDRY
                  C
                                                                                                                            NLDRY
                                                                                                                            NI ORY
687.
688.
694.
690.
691.
692.
693.
694.
697.
697.
699.
                                                                                                                            NL DRY
NL DRY
        C
                                                                                                                                        5666
                                                                                                                            NL DRY
         C
                                                                                                                                        4500
                                                                                                                            NLDRY
                                                                                                                            NLDAV
                                                                                                                            NL DRY
         C
                   LVDG = LVDG + LPTCGV+SGOCG + (AP/V - APV)
                                                                                                                            ML DAY
                                                                                                                           NLDRY
NLDRY
         C
                   LVDR = LVDR + ASF1(AMVR,AVVR) + LGTV+(AGR/V - AGVR)
+ LPTCGV+(APR/V - APVR)
 701.
                                                                                                                            NLDBY
         Ç
 702.
703.
704.
                   LVDT = LVDT + ASF1(AMVZ,AVVZ) - LM+AMV - LV+AVV
+ LGTV+(AGZ/V - AGVZ) + LGAM/V + (AG/V - AGV)
- - -+ LPS1/CGV + (APZ+TAUV - APVZ+TAU + AP/V - APV)
                                                                                                                           MTDBA
MTDBA
MTDBA
MTDBA
MTDBA
        C
 704 .
707 .
                   LGDG = LGDG - LPTCGV+AP+(2./CG2 - 1.)
        C
 7 OH .
                  LGDR = LGDR - LPTCGV+APR+SGOCG
                                                                                                                            MLDRY
 70¥.
710.
                                                                                                                           NLDRV
NLDRV
NLDRV
        C
                  LGOT = LGOT - SGOCG*(LPTCGV*APZ + LPSI*AP/CGV)
 /11.
/12.
         C
                  LRDR = LRDR + ASF1(AMRR, AVRR) - LGTV+AGRR - LPTCGV+APRR
                                                                                                                            NLDRV
713.
714.
                                                                                                                            NLDR4
NLDR4
         C
                  LROT = LROT + ASFI(AMRZ,AVRZ) - LM-AMR - LV-AVR

- LGTV-AGRZ - LGAM-AGR/V

- LPTCGV-APRZ - LPSI-APR/CGV
7 is .
7 is .
                                                                                                                            NLDRY
                                                                                                                           MLDRY
 /1/.
/10.
                   LADA = ASF1(AMMA, AVMA) - LGTV*AGMA
                                                                                                                           NLDRY
NLDRY
NLDRY
NLDRY
         C
                  LMDT = ASF1(AMMZ,AVMZ) - LM+AMM - LV+AVM
- LGTV+AGMZ - LPTCGV+APMZ
- LGAM+AGM/V - LPS1+APM/CGV
 720.
721.
722.
723.
        C
                                                                                                                           NLORY
                  LTOT = ASF1(AMZZ,AVZZ) - LGTV+AGZZ - LPTCGV+APZZ - LM+AMZ
- 2.+(LV+AVZ + L0AM+AuZ/V + LPSI+APZ/CGV)
                                                                                                                           MLDRY
124.
125.
125.
126.
                                                                                                                           NLDRY
                                                                                                                            JULIAB
        C
                                                                                                                           NLDRY
                 LVDM = ASF1(AMVM,AVVM) + LGTV+(AGM/V - AGVM)
+ LPTCGV+(APM/V - APVM)
                                                                                                                           NLBRY
120.
120.
120.
        C
                                                                                                                           NLDRY
                  LGDM =-LPTCGV+SGOCG+APM
                                                                                                                           MLDRY
/31.
/32.
                                                                                                                           NLDRV
NLDRV
         C
                  LRDM = ASF1(AMRM, AVRM) - LGTV+AGRM - LPTCGV+APRM
 733.
                                                                                                                           NLDRV
NLDRV
         0000
134 .
736 .
736 .
737 .
                                                                                                                           NLDRY
NLDRY
NLDRY
                  60 TO 5000
                                                                                                                                                 5000
/34.
/34.
                                        OPTIMAL CONTROL. ACCOUNT FOR EFFECTS OF APPLIED LOADS ON 1ST PARTS.W/RESP.TO STATE OF COSTATE EQS.
                                                                                                                           NI DRY
741.
           4500 LGDV = LVDG - LPTCGV+560CG+(APV - AP/V)
                                                                                                                           NLDRY
                D LBDV = LVDB - LPTCGV+SGCCG*(APV - AP/V)
LPDV = LVDP
LPDC = LGDP
LPDC = LGDP
LFDT = LVDT + LYTAU+ AVRV - LGTV*( AGRV - EAGR/V) - LPTCGV+
*( APRV - EAPR/V) + L#TAU+ AMRV
LFDG = LGDR + LYTAU+ AVRG - LGTV+ AGRG - LPTCGV+( APRG + SGCCG+EAP
*R)*LMTAU+ AMRG
LFDP = LPDR
LFDP = LPDR
LFDP = LPDR
142.
                                                                                                                           NLDRY
743.
144 .
145 .
146 .
146 .
                                                                                                                           NLDRY
                                                                                                                          NLDRY
NLDRY
NLDRY
                                                                                                                           NLDR #
```

 $\mathcal S$

```
LODG = LGDO

LODP = LPDO

LODR = LRDO

LODR = LRDO

LMDV = TAU*(-LV* AVMV -(LGAM* AGMV + LPSI/COSGAM* APMV)/V - LM*

* AMMV + (LGAM*EAGM + LPSI/COSGAM*EAPM)/V**0*2)

LMDG = TAU*(-LV* AVMG -(LGAM* AGMR + LPSI/COSGAM* APMG + SGOCG*EA |

*PM))/V - LM* AMMG |

LMDG = TAU*(-LV* AVMG -(LGAM* AGMR + LPSI/COSGAM* APMG)/V - LM*

* AMMR |

LMDV = TAU*(-LV* AVMG -(LGAM* AGMR + LPSI/COSGAM* APMG)/V - LM*

* AMMR |

LMDV = LVDT - LV*(AVV + TAU* AVZV) - LGAM/V*(AGV + TAU* AGZV - (AG*

* EAGZ)/V) - LPSI/CGV*(APV + TAU* APZV - (AP + TAU*EAPZ)/V) - LM*

* (AMV + TAU* AMZV)

LTOG = LGDT - LV*(AVG + TAU* AVZG) - LGAM/V*(AGG + TAU* AGZG) -

* * LPSI/CGV*(APG + TAU* APZG + SGOCG*(AP + TAU*EAPZ)) - LM*(AMG +

* * TAU* AMZG)

LTOP = LPDT -

LTOR = LRDT - LV*(AVR + TAU* AVZR) - LGAM/V*(AGG + TAU* AGZR)

* - LPSI/CGV*(APR + TAU* APZR) - LM*(AMR + TAU* AMZR)

LTOD = LOOT

LTOD = LV*(AVM + TAU* AVZM) - LGAM/V*(AGM + TAU* AGZM) - LPSI/CGV

** (APM + TAU* APZM) - LP*(AMM + TAU* AMZM)

LVDV = LVDV + ASF1( AMVV AVVV) - LGTV*(2.*AG/V2 - (EAGV +

- (EAFV + AFV)/V + APVV)

* - (EAFV + AFV)/V + APVV)
  750.
751.
752.
753.
754.
                                                                                                                                                                                                                       NLDRV
                                                                                                                                                                                                                       NLDRY
NLDRY
                                                                                                                                                                                                                        MI DRY
  755.
756.
757.
758.
759.
760.
761.
762.
(63.
                                                                                                                                                                                                                        NLDRY
                                                                                                                                                                                                                        MI DRY
                                                                                                                                                                                                                       NLDRY
                                                                                                                                                                                                                       NI DRY
                                                                                                                                                                                                                       NLDRY
NLDRY
NLDRY
   189 :
                                                                                                                                                                                                                       NLDRY
NLDRY
NLDRY
  767.
769.
769.
770.
771.
                                                                                                                                                                                                                       NLDRY
                                                                                                                                                                                                                      NLDRY
                                                                                                                                                                                                                      NLDRY
NLDRY
                                                                                                                                                                                                                       NLDRY
  773.
774.
775.
                                                                                                                                                                                                                       NLDRY
                                                                                                                                                                                                                      NLDRY
NLDRY
              C
                                                                       + ASF1( AMVG, AVVG) + LGTV*(AGG/V - AGVG)
+ LPTCGV*( 560CG*(AP/V - EAPV) + APG/V - APVG)
                                               = LVD6
                                                                                                                                                                                                                      NLDRV
 716.
717.
710.
                 C
                              .LVDR
                                                                                                                                                                                                                       NLDRV
                                                                         + ASF1( AMVR, AVVR) + LGTV+(AGR/V - AGVR)
+ LPTCGV+(APR/V- APVR)
                                                                                                                                                                                                                       NLDRY
 719.
               C -
                                                                      + ASF1( AMVZ, AVVZ) + LGTV+(AGZ/V - AGVZ)
+ LPTCGV+(APZ/V - APVZ)
- LV+EAVV - LM+EAMV + LGAM/V+(AG/V - EAGV)
+ LPSI/CGV + (AP/V - EAPV)
                                                                                                                                                                                                                      MLDRY
                                 LVOT
                                               = LVDT
                                                                                                                                                                                                                       NI DRY
  701.
702.
                                                                                                                                                                                                                      NLDRY
NLDRY
  184:
                                                                                                                                                                                                                      NLDRY
                C
  785.
                                                                                                                                                                                                                      NI DRV
                                                                                                                                                                                                                      NLDRY
NLDRY
                                 L6D6
                                                       LGDG - LPTCGY+(AP+(2./CG2 - 1.) + SGOCG+APG)
  786.
767.
780.
                C
                                 LGDR
                                                        LGDR -LPTCGV+APR+5GDCG
                                                                                                                                                                                                                      NLDRY
NLDRY
                C
  784.
790.
791.
                                                                                                                                                                                                                      NLDRY
NLDRY
                                                         LGDT - LPSI/CGV+SGOCG+(AP + TAU+APZ)
                 C
                                                        LROR + ASF1( AMRR, AVRR) - LGTV+ AURR - LPTCGV+ AFRR
 791.
192.
193.
194.
196.
196.
197.
198.
                                 LROR
                                                                                                                                                                                                                      NLDRY
                 C
                                                                                                                                                                                                                      NLDRV
                                              = LRDT + ASF1( AMRZ, AVRZ) - LGTV+ AGRZ - LPTCGV+ APRZ
- LV+EAVR - LM+EAMR - LGAM+EAGR/V - LPSI+EAPR/CGV
= ASF1( AMVM) + LGTV+(AGM/V - AGVM) +
LPTCGV+(APM/V - APVM)
                                 LADT
                                                                                                                                                                                                                      NLDRV
NLDRV
                                LVDM
                                                                                                                                                                                                                      NLDRY
                                                                                                                                                                                                                      NLDRV
                                                                                                                                                                                                                      NLDRY
NLDRY
                C
                                              =-LPTCGV+APM+SGOCG
                                 LGDM
                C
                                                                                                                                                                                                                      NLDRV
800.
801.
                                 LRDA
                                                                                                                                                                                                                      NLDRY
NLDRY
NLDRY
                                              = ASF1( AMRM, AVRM) - LGTV+ AGRM - LPTCGV+ APRM
               C
 883:
                                 LADA = ASF1( AARA, AVRA) - LETV+ AGRA - LPTCGV+ APRA
                             LADT
 804.
               c
                                                                                                                                                                                                                      NLDAY
                                                        ASF1( AMMZ, AYMZ) - LGTV+ AGMZ -
- LV+EAVM - LM+EAMM - LGAM+EAGM/V -
                                                                                                                                                                                                                      NLDRY
NLDRY
NLDRY
80».
80%.
80%.
80%.
810.
811.
812.
814.
814.
814.
               C
                              LTDT = ASF1( AMZZ, AVZZ) - LGTV+ AGZZ - LPTCGV+ APZZ

- LV*(EAVZ + AVZ) - LM*(EAMZ + AMZ) - LGAM*(EAGZ + AGZ)/V

- LPSI*(EAVZ + APZ)/CGV

- LPSI*(EAVZ + APZ)/CGV

STILL OPTIMAL CONTROL. COMPUTE 1ST PARTS.W/RESP.TO

COSTATE OF STATE EQS.
                                                                                                                                                                                                                      NLDRY
NLDRY
                                                                                                                                                                                                                      NLDRY
                                                                                                                                                                                                                      NLDRY
                                WDFA =
BDFA =
BDFA =
ADFA =
                                                     TAU+AYLY
TAU+AGLY
TAUCGY+APLY
TAU-AMLY
                                                                                                                                                                                                                     NLDRY
NLDRY
                                                                                                                                                                                                                     MLDRY
                                                                                                                                                                                                                     NLDRY
               C
                                VDLG
GDLG
PDLG
MDLG
                                             =
=
=
                                                     TAU+AVLG
TAUV+AGLG
TAUCGV+APLG
TAU+AMLG
                                                                                                                                                                                                                     NLORY
814.
                                                                                                                                                                                                                     MLDRY
                                                                                                                                                                                                                     NLDRY
NLDRY
NLDRY
822:
823. C
                                 VOLP = TAU+AVLP
                                                                                                                                                                                                                     NLORY
```

```
NLDRY
NLDRY
NLDRY
NLDRY
NLDRY
NLDRY
NLDRY
NLDRY
825.
826.
827.
828.
829.
                                                   SDLP = TAUV*AGLP
POLP = TAUCGV*APLP
MOLP = TAU*AMLP
                        C
                                                   RETURN
                                                                                                              NON-OPTIMAL CONTROL. THE 1ST PARTS.W/RESP.TO
COSTATE OF THE COSTATE EQS. ARE GIVEN BY NEGATIVE
TRANSPOSE OF THE 1ST PARTS.W/RESP.TO STATE OF THE
STATE EQS.
830.
831.
832.
834.
                          0000
                        SOOO CONTINUE

DO 10 1 = 1, 9

K = I + 9

DO 10 J = 1, 9

10 JACOB(J + 9, K) = -JACOB(I, J)

C ALSO FOR NON-OPTIMAL CONTROL, THE 1ST PARTS.W/RECP.

TO STATE OF THE COSTATE EQS. FORM A SYMMETRIC

MATRIX, SD FILL IN LOWER TRIANGULAR PORTION.
                                                                                                                                                                                                                                                                                                                                           NLDRY
8 35 . 8 37 . 8 38 . 8 38 . 8 39 . 8 40 . 8 41 . 8 42 . 8 44 . 8 44 . 8 46 . 8 50 . 8 51 . 8 52 . 8 53 .
                             CONTINUE

0000 CONTINUE

00 20 I = 2, 9

L = I + 9

K = I-1

00 20 J = 1, K

20 JACOB(L, J) = JACOB(J + 9, 1)
                        0000
                                                   RETURN
END
```

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BL	STOF OCK	AGE LOC	SUBFOL SUBR	CODE	USAGE VAR
AE	Aexit	1	Total nozzie exit area (FT	2) /041	1A /	(89) APPLY ARCIN IMPULS NLDBY TH2	O I I	AE AE AE AE
APLP	∂a*/∂λ _*	1	The first entry in a 4x3 matrix that contains $\partial a/\partial \lambda_y$, $\partial a/\partial \lambda_y$ and $\partial a/\partial \lambda_y$	/AXI	.E /	(335) APPLY NLDRV		APLP
AV	a ^v		The first word of a four word array that contains the vector of applied accelerations defined by Equation 2.4-2 in Vol.1 of this document.	/AXL	.E /	(1	APPLY APPLY NLDRY	0	AXLE AX
	∂a ^v /∂v	1	The first entry in a 4x8 matrix that contains the total partial derivatives of the a vector gith respect to the OL state vector (excluding the heating state), \$\partial ax/\partial y\$.	/AXL	.E /	(5) APPLY NLDRY	Ħ	AVV
AVVG	∂(δa [¥] /δV)/∂γ		The first entry in a 4x8 matrix that contains a(5a/6y)/aY	/AXL	.E /	(101	NLDRY	1	AVVG
AVVP	∂(δ 2^V/ δV)/∂ ψ	ī	The first entry in a 4×8 matrix that contains ∂(δs/δy)/∂ψ	/AXL	.E /	(133	NLDRV	I	AVVP
AVVR	∂(δa [▼] /δV)/∂h	1	The first entry in a 4x8 matrix that contains ∂(δe/δy)/∂h	/AXL	.E /	(165	APPLY NLDRV		AVVR AVVR
AVVV	∂(δa[♥]/δV)/∂V		The first entry in a 4x8 matrix that contains ∂(5a/6y)/∂V.	/AXL	E /	(69)	APPLY APPLY NLDRY	I	AVVV AVV AVVV
. с	c		A forty mord array containing the vector of c's, i.e. the multipliers for the homogeneous solutions.	/0	,	(11 :	BNDRY BRANPT GROPE INTRPT NEWCS	I I I M I	
CODAE	c ο s (α - δ _E)	İ	See symbol	/ DY N	A /	(1511	ALI AL4 AL6 AL7 AL8 AL9 APPLY CONTRL NLDRY TH3 UT	I I I I I I I	CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE CODAE
COSA	C 0 S &	ī :	See symbol .	/ DYN	A /	101	ALI AL4 AL6 AL7 AL8 AL9 APPLY CONTRL NLDRY OUTPUT TH3 UT	I	COSA COSA COSA COSA COSA COSA COSA COSA
COSGAM	C087	1 !	See symbol	/DYN	A /(4)	ALI AL4 AL7 AL8 AL9 CONTRL	I (I (I (I (I (I (I (I (I (I (COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM

FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION	STORAGE BLOCK LOC	SUBROUTINE USAGE
COSPSI	c o s √	1 See symbol	/DYNA /(95	AL4 I COSPSI AL7 I COSPSI AL8 I COSPSI AL9 I COSPSI COMTRL I COSPSI NLDRY I COSPSI PDBCOL I COSPSI STATEF O COSPSI
COSRHO	C 0 S P	1 See symbol	/DYMA /L 97)	AL4
C052R0	c o s 2 <i>p</i>	I See symbol .	/DYNA /(120)	AL4 I COS2RO AL7 I COS2RO AL8 I COS2RO NLDRY I COS2RO STATEF O COS2RO
DB -	D _b	i Base drag (LBS)	/DYNA /(163)	AL1 I DB AL4 I DB AL4 I DB AL7 I DB AL8 I DB AL9 I DB APPLY I DB CONTRL I DB NLDRY I DB STATEF I DB TH3 I DB UT I DB
OR A G	D	I Merodynamic drag (LBS)	/DYNA /(69)	ALS I DRAG AL7 I BRAG AL8 I DRAG AL9 I DRAG APPLY I DRAG CONTRL I DRAG EMYPRQ I DRAG NLDRY I DRAG OUTPUT I DRAG OUTPUT I DRAG UT DRAG
EAVV	δ a ^v / δ v	1 The first entry in a 4x8 matrix that contains, when a is optimal, $\delta a/\delta y = \partial a/\partial y \Big _{\alpha} = constant$ When a is nonoptimal,	/AXLE /(37)	APPLY I EAVY NLDRY I EAVY
FVAC		6a/6y = ∂a/∂y I Total vacuum thrust (rocket) (LBS)	/DYNA /(33)	APPLY I FVAC ARCIN M FVAC IMPULS M FVAC NLORV I FVAC STATEF M FVAC TM2 I FVAC
6	g	I Instantaneous gravitational acceleration (FT/SEC ²)	/DYNA /(8)	AL4 I G AL7 I G AL8 I G AL9 I G CONTRL I G NLDRY I G STATEF M G
GAMMAD .	-	I Pitch rate (RAD/SEC)	/DYNA /(88)	AL4 I GAMMAD ARCIN O GAMMAD CONTRL I GAMMAD NLDRY I GAMMAD

SYMBOL	MATH Symbol	CODE DESCRIPTION	STORA: BLOCK	LDC LDC	SUBROUTINE SUBR CODE	VAR
GH	∂g/∂R	1 See symbol	/DYNA /C	142)	AL8 J NLDRV I	6H 6H 6H
GRR	a ² g/aR ²	1 See symbol	/DYNA /(143)	AL7 I AL8 I NLDRY I	GRR GRR GRR GRR
EAT#		I Atmosphere option flag	/ARCDAT/(7)	NLDRV I OUTPUT I	MTAI MTAI MTAI
B ÇQA		An 18x18 array defined by Equation 17.5-5 in Voil of this document. The entry in the i-th row and j-th column is the total partial derivative of the quasitime derivative of the Y ₁ component of Y sith respect to the Y ₂ component of Y, i.e., 3Y ₁ /3Y ₂ ,	/JACOB /(.	1)	NLDRY M	JAKE JACOB VDV JAKE
		where $v^{T} = (y^{T}, \lambda^{T})$				
KODE	. •	I Steering vector flag KODE = 0: Free fail, a = 0 = 0; KODE = 1: Both a and 0 optimal; KODE = 2: a optimal and 0 = 0; KODE = 3: a nonoptimal and 0 optimal; KODE = 4: Vertical rise or pitchover; KODE = 5: a nonoptimal and 0 = 0.	/DYNA /(25)	CONTRL M FORCES I INLORV I	KODE KODE KODE KODE KODE
CODES		M Not used.	/CNTRL /(56)	NLDRY M 1	KODES Kodes Kodes
CONVER		I Logical flag that indicates to the QL module that the QL iteration is converged.	/CNTRL /(28)	APPLY I ARCIN I COHOMO O GROPE O NLDRY I COUTPUT I	KOWAE KOWAE KOWAE KOWAE KOWAE KOWAE
LGAR	λ,	I Relative flight path angle costate	/B /(101)	CONTRL I I	LGAM LGAM LGAM LGAM LGAM
LHT	λ	I Heating costate .	/0 /((801	NLDRY I	LHT LHT
.я	λ	I Mass costate	/0 /(106)	NLDRY I L	LM LM LM
.AU	λ_{μ}	I Relative longitude costate	/D /(105)	NLDRY I L	- MU - MU - MU
.P51	$\lambda_{m{\phi}}$	I Relative azīmuth angle costate	/D /(102)	ARCIN I L CONTRL 1 L NLDRY I L OUTPUT I L	LPSI LPSI LPSI LPSI LPSI LPSI
R	$\lambda{_{\mathbf{R}}}$	I Altitude costate	/B /(103)	NLORY I L	LA LA
.RH0	λ _p	I Latitude costate	/0 /(104)	OUTPUT I L	LRHD LRHD LRHD

FORTRAM SYMBOL	MATH Symbol	COD	DESCRIPTION		S1 BLOC	TORAG K	LOC E	SUBROUT!	NE USAGE DE VAR
LV	λ,	1	Relative velocity costate		/D	/(100)	ALI I CONTRL I NLDRY I OUTPUT I WRAPUP I	FA FA FA FA
R	•	I	Mass	(6'5)	/0	/(97)	AL4 I AL7 I AL8 I AL9 I APPLY I BRANPT I COSTAB I COSTAB I INTRPT I	# # # # # # # # # # # # # # # # # # #
								NLDRY I OUTPUT I SALVE I STATEF I WRAPUP I	K K K K
H		I	Total number of QL state and costate variab = 18.	ies. N	/PC	/(BNDRY I CHECK I INARC I LINDRY I NLDRY I NDRNAL I RKUTTI I SALYE I WRAPUP I	AL AL AL AL AL AL AL AL AL AL AL AL AL A
NO M	v		Relative velocity.	(FT/SEC)	/0	π.	91)		V V V V WOR NOR V V V V V V V V V V V V V V V V V V V
DREGAT	2₩ (1	See symbol		/DYNA	/(12)	NLDRV I Trajin O	OMEGAT OMEGAT
OMEGA2	⊌ ²	1	See symbol		/DYNA	/(6)	AL4 I AL7 I AL8 I AL9 I NLDRV I TRAJIN O	OMEGAZ OMEGAZ OMEGAZ OMEGAZ OMEGAZ OMEGAZ
PA	Pa	I	Atmospheric pressure (1	.BS/FT ²)	/DYNA	/(14)	IMPULS I NLDRV I OUTPUT I TH2 I	PA PA PA PA
PAULT	= 0 0R 1	1	Heating flag multiplier		/ARCDA	T/(NLDRV I POBCOL I	OMULT OMULT

FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION		BLOCK	LOC	SUBROUT	INE USAG
STRIBUL	SYMBUL	220011111011		BLUCK	LUL	SUBIT L	DE TAK
R	R	I Radial distance from earth center to vehi	cle (FT)	/DYNA /6	. 1)	AL4 AL7 AL8 AL9 CONTRL ENVPRQ NLDRV POBCOL DITOSZ STATEF	· · · · · · · · · · · · · · · · · · ·
RHDB	Pb	I Atmosphere base density for heating calcu	lation (LB/FT++3)	/ARCDAT/(39)	NLDRY 1	
RQ	, Pa		(SL6S/FT ³)	/DYMA /(15)	AL7 AL8 AL9 AL9 NLDRV OUTPUT 1 PDBCQL 1 STATEF 1	RO RO RO RO RO
10R	∂ o _/∂R	1 See symbol		/DYMA /(19)	AL7 I AL8 I AL9 I NLDRY I POBCOL I STATEF I	ROR ROR ROR ROR ROR
IORR	3 ² 0 ₀ /3R ²	3 See symbol		/DYNA /(23)	AL7 J AL8 I AL9 I WLDRV I STATEF I	RORR RORR RORR
INGAM	\$ 1 n 7	1 See symbol		/DYNA ,/C	3)	ALI II AL4 II AL7 II ALB II AL9 II CONTRL II NLDRY II POBCOL II STATEF F	SINGAP SINGAP SINGAP SINGAP SINGAP SINGAP
INPSI	sin∳	I See symbol		/BYNA /(941	AL4 I AL7 I AL8 I AL9 I CONTRL I NLDRY I POBCOL I STATEF O	SIMPSI SIMPSI SIMPSI SIMPSI SIMPSI SIMPSI SIMPSI
I NR HÖ	sinp	1 See symbol		/BYNA /(96}	AL4 II AL7 II AL8 II AL9 II CONTRL II NLORV II DUTPUT II POBCOL II STATEF M	SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO SINRHO
1 N2RQ	2 i n 2 p	I See symbol		/DYNA /(119)		SIN2RO SIN2RO SIN2RO SIN2RO
AU	7	I Subarc duration	(SEC)	10 10	981	ARCEN I INARC M NLDRV I OUTPUT I STATEF I	TAU



FORTRAN Symbol	MATH Symbol	COO	DESCRIPTION					SUBROU SUBR	CODE	E VAR
٧	V		Relative velocity. (1	T/SEC)	/8			ALT ALT ALB BCOMD BNDRY CONTRL ENPPT ENPPRO FETCH INTERPT NLDRY OUTPUT STATES	N 1 1 0 M M 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A A A A A A A A A A A A A A A A A A MO W WO W W
VOV		я	of this document. The entry in the i-th row th column is the total partial derivative of quasitime derivative of the Y _i component of V	and j- the	/JACOB	/(1)	LINDRY NLDRY NLDRY SALVE	n	TWKE ADA TWCOB
	V	V V	V V I	VDV An 18x18 array defined by Equation 17.5-5 in of this document. The entry in the i-th rose th column is the total partial derivative of quasitime derivative of the Y; component of Y, 1.s.,	VDV M An 18x18 array defined by Equation 17.5-5 in Voi. 1 of this document. The entry in the 1-th row and j-th column is the total partial derivative of the quasitime derivative of the respect to the Y; component of Y, I.s.,	VDV An 18x18 array defined by Equation 17.5-5 in Vol.1 /JACOB of this document. The entry in the 1-th row and j-th column is the total partial derivative of the quasitime derivative of the Y component of V alth respect to the V component of V, 1.s.,	VDV An 18x18 array defined by Equation 17.5-5 in Vol.1 /JACOB /(of this document. The entry in the 1-th row and j- th column is the total partial derivative of the quasities derivative of the Y; component of Y mith respect to the Y; component of Y, 1.s.,	VDV M An 18x18 array defined by Equation 17.5-5 in Vol. [/JACOB /(1) of this document. The entry in the i-th row and j-th column is the total partial derivative of the quasitime derivative of the Y ₁ component of Y ₂ l.s.,	V V I Relative velocity. (FT/SEC) /B /(91) AL1 AL7 AL8 AL9 BEOMD BROWN BRAMPT CONTRL EMPT ENVPRO FETCH INTERP INTERP OUTPUT POBGGL STATEF WRAPUP VDV M An 18x18 array defined by Equation 17.5-5 in Voi.[/JACOB /(1) LINDRY of this document. The entry in the 1-th row and j- th column is the total partial derivative of the quasitiae derivative of the V; component of V mith respect to the V; component of V, 1.s.,	V V I Relative velocity. (FT/SEC) /B /(91) ALI I AL7 I AL8 I AL9 I BCOND I BBNDRY OF CONTRL I ENVPRO I FETCH OF NLDRY I OUTPUT I STATEF I FORCED I STATEF I



SUBRØUT I NE NØMNAL



Purpose

NOMNAL combines up the particular and homogeneous solutions resulting from the preceding iteration to get the total solution from the preceding iteration,

s = p + Hc.*

^{*}See Sections 17.1 and 17.2 of Vol. I.

NOMMAL

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1. C C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C D . C
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                                                                                                                                                                                                                                                                                   SUBROUTINE NOMNAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NOMNAL
NOMNAL
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OD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          THIS ROUTINE COMBINES UP THE PARTICULAR AND HOMOGENEOUS SOLUTIONS TO YIELD THE TOTAL SOLUTION.
                                                                                                                                                                                                                    GENEOUS SOLUTIONS TO VIELD THE TOTAL SOLUTION.

REAL MAGBY, MU, M, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU, NOM

* LHT
COMMON /D/

*X, H, XI(4), MAGBY, ERR, D9, D10, C(40), CSAVE(40), Y, GAM, PSI,
*ALT, AHO, MU, M, TAU, HT, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU,
*LHT, D109, D110, BV(40), 2SAVE(20), D1(20), NPOINT(20), DELT(20)
D1MENSION MOM(20)
EQUIVALENCE (NOM, V)
COMMON /S/S
COMMON /S/S
COMMON /S/S
COMMON /S/S
COMMON /S/S
COMMON /S/S
*ARD INDOX(4), NEWNOM, CATO16 RHOC, RHOP, NPTS, MINES,
*NPAGE, NNP, NUP, IARC, TRSTR, IMAX, KTIME, KONVER, NOPRNT,
*INBORY, NUPAGE, IVARY(20), NN, NOVARY, PLAST, ZLAST, KODES
COMMON /PL/S
COMMON /PL/S
COMMON /PC/
*PC1 NN PC3 ,IDP, PC5 ,PC6 ,PC7 ,MAXBC, NAUX
DIMENSION S(820)
IF(NN - N) 1, 1, 2

READ(ITAPA) (S(IK), IK = 1, NN)

2 READ(ITAPA) (S(IK), IK = 1, NN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               JUL21
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                                                                                                                                                                                                                                    2 READ(ITAPA) (S(IK), IK = 1, NN)
CALL MATMLT(Z, S(N + 1), C, N, MOM, 1)
CALL MATADD(Z, Z, S, N, 2)
RETURN
END
                               28.
29.
30.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NOMNAL
Nomnal
Nomnal
                               3<sub>1</sub>.
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NOMNAL
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FORTRAN	MATH	CODE	DESCRIPTION		ORAG		SUBROU		
SYMBOL	SYMBOL		DESCRIPTION	BLOCK	<u> </u>	FOC	SUBR	CODE	VAR
C	C	1	A forty mord array containing the vector of, c's, i.e. the multipliers for the homogeneous solutions.	/D	/(11)	BNDRY BRAMPT GROPE INTRPT NEWCS NLDRY NOMNAL WRAPUP	I I I M I I	00000000
ITAPA		I	Number of the logical unit containing the quasitime histories of the particular and homogeneous solutions from the preceding QL iteration.	/CNTRL	/(3)	GROPE Nomnal		ITAPA ITAPA
M0M		1	The number of homogeneous solutions currently being integrated.	/CNTRL	/(. 91	GROPE INARC LINDRY NOMNAL SALVE WRAPUP	H I	RD M RD M RD M RD M RD M
N			Total number of QL state and costate variables. N = 18.	/PC	16	2)	NLDRV NOMMAL RKUTTI		
un .			The-number-of quantities currently being numerically integrated.	/ENTRL	/(52 }-	NOMNAL REUTTS FEUTTZ SALVE	M	# M # N # N # N # N # N # N # N # N # N # N
5			An 820 mord erray used to store the particular and homogeneous solutions.	. 12	/(1)	NOMMAL REUTT1		
2	Z		A 20 mord array used to store the total linear solution from the preceding QL iteration.		/(ENDPT ENVPRO INTERP INTRPT LINDRV NOMNAL OUTPUT RKUTTI RKUTTI	1 2 2 1 2 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2	

SUBRØUT I NE NPLANE



Purpose

NPLANE controls the calculation of the in-plane control vector.

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2.
3.
                                  SUBROUTINE MPLANE
                                                                                                                                                                                                                                    NPLANE
                                                                                                                                                                                                                                   NPLANE
NPLANE
NPLANE
NPLANE
                0000
                                                                          THIS ROUTINE CONTROLS THE CALCULATION OF THE IN-
PLANE CONTROL QUANTITIES T, DELTAE, AND ALPHA.
                                                                                                                                                                                                                                  NPLANE
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
ARCDAT
                               COMMON/ARCDAT/
*SREF EJ
*IATM IMODE
*XLMAX HDMAX
*MAEB MAEC
*MT MISP
*MDB XCGM
                                                                                               XISP
JAER
GMDOT
,MAED
,MXCG
,ZCGR
,RHOB
                                                                                                                              TMULT
JPRO
ALFMAX
MAEE
MZCG
                                                                                                                                                              , QMAX
, PHMAX
, MAEF
, MWDA
, ZE
, REMAX
                                                                                                                                                                                              , GMAX
, MAEA
, MAEG
, MWDB
                          ARCDAT
ARCDAT
                                                                                                                                                                                                                                   DYNA
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DYNA
DYNA
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JUL21
DYNA
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                            . X K 2 M A
. X K 2 Z A
. X K 2 D V
. X K 2 D Q
. X K 2 D G
. X K 2 D G
. X K 2 Z G
                                                                    XK3M0
XK3ZD
XK3ZV
XK3ZV
XK3ZV
XK3RJ
                                                                                        , XK1MA
, XK1ZA
, XK1PV
, XK1UV
, XK1UV
, XK1UG
, XK1UG
                                                                                                                               , XK3MA
, XK3ZA
, XK3PV
, XK3UV
, XK3GG
, XK3OG
                                                                                                                                                    , XK127
, XK184
, XK184
, XK196
, XK196
, XK199
, XK109
                                                                                                                                                                                            X K 3 Z V

X K 3 R V

X K 3 R V

X K 3 P G

X K 3 P P

X K 3 U P
                                                                                                                                                                            XK2VV
XK2RV
                                                                                                                                                                         , XK2RV
, XK2RV
, XK2PG
, XK2UG
, XK2PP
, XK2UP
                                                                                       XKIZG
                                                                    XK3AG
XK3AP
                                                                                                            XK2Z6
XK2OP
                                                                                                                                , XK3Z6
```

```
111 IF(ALFMAX .LE. O. .OR. ABS(ALPMA) .LE ALMAX) GO TO 112

C ALPMA = SIGN(ALMAX, ALPMA)
INQF = 0
J3 = 2
CALL ALGCON(J1 J2, J3)
C CHECK FOR POWERED ACCEL. LIMIT.

112 CALL THROTL
IF(SWITCH) CALL ALGCON(J1, J2, J3)
RETURN
END
                                                                                                                                                                                                                                                                                                                                     NPLANE
NPLANE
NPLANE
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147.
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NPLANE
NPLANE
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FORTRAN Symbol	MATH Symbol	COBI	DESCRIPTION		STORAL BLOCK	LOC	SUBROUTIN SUBR COD	E USAGE E VAR
ALFMAX		1	Maximum angle of attack	(DEC)	/ARCDAT/(141	ARCIN I	ALFRAZ
ALMAX	^Q MAX		Magnitude of angle of attack constarint	(RADS)	/DYNA /(NPLANE I	ALFMAX
ALPHA	a	ı	Angle of attack	(RAD)	/DYNA /(791	NPLAME I AEROCO I	ALPAX ALPHA
-	-	•		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	•••	ALGCON MAL2 I ARCIN M CONTRL M ENVPRS I MOMECO I NPLANE I OUTPUT I TRAJIM O UT I WRAPUP I	ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA
CALPHA	c.	0	Value for angle of attack in case constant attack constraint is used.	angle of (RAUS)	/DYNA /(161)	ALZ I NPLANE O	CALPHA Calpha
CULFT	c _{L,}	0	Magnitude of untrinned lift limit	(LBS)	/DYNA /(165)	AL3 I NPLANE D	CULFT
GMAX	GMAX	1	Maximum total acceleration g load		/ARCDAT/(12)	AL5 I NPLANE I THROTL I TH3 I	GMAX GMAX GMAX
I DAM	-	- 0	Optional atmospheric calculations flag. IDAM = -1: Compute $\partial^3 \rho_{\rm B}/\partial {\rm R}^3$; IDAM = 0: No optional calculations; IDAM = 1: Compute $\partial^3 \rho_{\rm B}/\partial {\rm R}^3$, $\mu_{\rm B}$, $\partial \mu_{\rm B}/\partial {\rm R}$, etc.	/DYNA -/{	218)	ARCIN O ERROR I NPLANE D STATEF I WRAPUP O	IDAM IDAM IDAM IDAM IDAM
ILOAD		1	Logical flag that is true if there is any aerodynamic load on the vehicle.		/DYNA /(181)	ARCIN M CONTRL I NPLANE I UT I	ILOAD ILOAD ILOAD ILOAD
I MODE		I	Control mode option flag		/ARCDAT/(8)	ARCIN I CONTRL I NPLANE I	I MODE I MODE I MODE
I NQF		A	State variable inequality constraint flag. INGF = 0: No SVIC in effect; INGF = 1: Dynamic pressure IC in effect; INGF = 8: Heating rate SVIC in effect; INGF = 9: Reynolds number SVIC in effect		/DYNA /(185)	ARCIM M NPLANE A	INOF- INOF
I POW		ī	Powered fiag. IPOW = 0: No thrust and no base drag IPOW = 1: Thrust, but no base drag IPOW = 2: Thrust and base drag		/DYNA /(139)	ARCIN M FORCES I NPLANE I STATEF I THROTL I	IPOM IPOM IPOM IPOM IPOM
11		1	Thrust option flag. J1 = 1: Constant thrust; J1 = 2: Input vacuum thrust; J1 = 3: Pomered total acceleration ilm J1 = 4: Air-breather engine.	lt;	/DYNA /(173)	APPLY I ARCIM O CONTRL M FORCES I NPLANE I STATEF I THROTE M)1 11 11 11 11
12		1	Engine deflection option flag. J2 = 1: Constant engine deflection; J2 = 2: Moment balancing.		/DYNA /(174)	ARCIN O CONTRL I NPLANE I	J2 J2 J2
13	-	A	Angle of attack option flag. J3 = 1: Optimal angle of attack; J3 = 2: Constant angle of attack; J3 = 3: Untrimmed lift limit; J3 = 4: Vertical rise or pitchover; J3 = 5: Unpowered total acceleration i J3 = 6: Gravity turm; J3 = 7: Dynamic pressure constraint; J3 = 8: Heating rate constraint; J3 = 9: Reynolds number constraint.	imit;	/DYNA /(175)	ARCIN G CONTRL M NPLANE M OUTPUT I	13 13 13



FORTRAM SYMBOL	MATH Symbol	CODE	DESCRIPTION		STO BLOCK	RAG	LOC	SUBROU SUBR		USAGE
SWITCH	 	ī	Logical flag that is true if this is the compute point at which the powered acceleration constrai commences.	int	/DYNA	/(184)	CONTRL NPLANE THROTL	1	SWITCH SWITCH SWITCH
ULFT	L.	1	Untrimmed merodynamic lift (L	LBS)	/DYNA	/(164)	AL3 NPLANE UT	I	ULFT ULFT ULFT
XLMAX	Lmax	1	Maximum merodynamic (ift (L	85)	/ARCBAT	/(13)	NPLANE	ı	XLMBX



SUBRØUT I NE ØUTPUT

Purpose

OUTPUT puts print quantities into the print array AP and controls the computation of auxiliary print quantities.

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2.
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151.	AP(5)=PSIDG	OUTPUT	1
152.	AP(6)= MU+RAD	OUTPUT	i
153. 154.	AP(7)= RHO+RAD AP(8) = Tau+XX	0UTPUT 0UTPUT	į.
155.	AP(9)= M	OUTPUT	i
	M0=0	DUTPUT	ł
156.	CALL POBCAL(-1,FF,FF,FF,O,MO)	OUTPUT	ł
1>0.	AP(10) = VI	001PUT 709FU0	ł
159.	AP(11) = GAMI*RAD AP(12) = PSII*RAD	OUTPUT	j
160.	AP(13) = XMUI+RAD	OUTPUT	Į
161.	AP(14) = SCROSS+FTMM	OUTPUT	1
163.	AP(16)= M	00TPUT 00TPUT	1
164.	AP(18)= MT AP(19) = 2D(9)	OUTPUT	3
les.	AP(20) = STOT +FTMM	CUTPUT	ŀ
166.	AP(21) = SDOWN+FTMM	OUTPUT	i
160.	IF(IATM .LT. 2) RE = V+RO/VNU	0UTPUT 0UTPUT	1
169.	AP(22)= RE AP(23)= PA	OUTPUT	
1/0.	AP(24)= RO	OUTPUT	
1/1.	AP(25)= CS	OUTPUT	l
1/3.	AP(26)= MACH	OUTPUT	l
1/4.	AP(45) = J3 AP(46)= XK3	0uTpuT 0uTpuT	
1/>.	AP(29) = ALPHA+RAB	OUTPUT	
176.	AP(30) = PHI*RAD	DUTPUT	
177.	SACHI = SINA+COSPHI	OUTPUT	:
1/4.	IF(ABS(SACHI).GT.1.) SACHI=SIGN(1.,SACHI)	00TPuT 00TPuT	[
140.	SASHI=SINA+SINPHI IF(ABS(SASHI).GT.1.) SASHI=SIGN(1.,SASH)	OUTPUT	
101.	AP(92)= GAMD + ASIN(SACHI)#RAD	OUTPUT	
102.	AP(93) = PSIDG + ASIN(SASHI)+RAD	OUTPUT	
100.	AP(31)= XJ	DUTPUT	l
100 .	AP(32)= 0 AP(33)= xmc6	OUTPUT OUTPUT	ĺ
100.	AP(34)= LIFT	OUTPUT	
107.	AP(35)= DRAG	OUTPUT	ł
] 20. 107.	AP(36)= T	OUTPUT	
1 40.	1F(ZO(7) .EQ. 0.) GO TO 10 AP(43) = -T/ZO(7)/GROTAU	OUTPUT OUTPUT	16
191.	60 TO 20	OUTPUT	20-1
193.	10 AP(43)=0.	OUTPUT	
194.	20 CONTINUE	TLALO	
195.	AP(48)= DELTAE *RAD	DUTPUT	
196.	IF(JAER-2) 30,30,40	001001	30 70
197.	30 AP(49)= (T + LIFT+SINA-DB - DRAG+COSA) / W	QUTPUT	
198.	AP(50)= (LIFT=COSA+ DRAG+SINA)/ W	BUTPUT	
199.	60 10 50	Output	50
200. 201.	40 AP(49)= (T+COD +LIFT+SINA-DB -DRAG+COSA) / #	OUTPUT	
	AP(50)=(LIFT+COSA+DRAG+SINA-T+SID)/W	OUTPUT	لسيا
202.	50 AP(51)=SQRT(AP(49)*+2+AP(50)*+2)	801901	
203. 204.	AP(27)= CL AP(28)= CD	0utput 0utput	
205.	AP(37) = LV	OUTPUT	
206.	AP(38) = LGAM	דט פדע פ	
201.	AP(39) = LPSI	OUTPUT	
200.	AP(40) = LR	759760 Tuqto0	
200. 210. 211.	AP(41) = LRHO AP(42) = LAU	DUTPUT	
210.	AP(44) = LM	OUTPUT	
211. 212.	AP(47) = LTAU	OUTPUT	
213.	CALL COORDS(COSRHO SINRHD) IF(IPFLG1.NE.O) 60 10 60	0UTPUT 0UTPUT	66-7
214	AP(62)= SAIMAJ +FTNM	OUTPUT	"
21>.	AP(63)=ECC	QUTPUT	1
214.	AP(64)=AINCL + RAD	OUTPUT	
	AP(65)= ASCNOD+ RAD	0uTPuT 0uTPuT	
210.		001701	
215. 216. 217. 218. 218.	AP(66)= ARGP * RAD AP(67)= APOGFF * FTMM		. 1
219.	AP(67)= APOGEE * FTNM AP(68)= PERGEE * FTNM	109100 109100	i
219.	AP(67)= APOSEE + FTMM	OUTPUT	

			1	
224.	AP(71)=ENERGY	OUTPUT	1	
225.	AP(72)=HBMTA -	OUTPUT	i i	
226.	AP(73) = P+FTNM	OUTPUT	1 1	
227.	AP(74)=HMNTM /APOGEE	OUTPUT		
228.	AP(75)=HMNTM / PERGEE	DUTPUT	1.	}
229.	60 CONTINUE	DUTPUT		,
230.	IF(IPFLG3. NE. 0) 60 TO 70	DUTPUT	70-	1
231.	IKONAK = 0	OUTPUT	!!	
232.	IF(KONVER) IKONVR = 1	DUTPUT	l i	
233.	IF(.NDT.KONVER) 60 TO 90	001Pu1	, ,	90-
234.	IF(V.LT.300OR.ABS(COSGAM).LT001) 60 TO 70	JUL21	70-4	
23	CALL CRASH	OUTPUT	1.	,
236.	70 CONTINUE	CUTPUT		
237.	IF(.NOT.KONVER) GO TO 90	OUTPUT	90	
2 30 .	IF(IPFL61.NE.0) 60 TO 90	001701	90	
239.	AP(17) = Z(19)	BUTPUT	ł	
240.	AP(55) = Z(20)	OUTPUT	l	
241.	AP(56) = Z(22)	TU9TUO	l	
242.	AP(57) = Z(23)	0UTPU T	1	
2-2.	AP(58) = Z(21)	OUTPUT	١.	4
244.	90 CONTINUE	Output		
245.	CALL PRINT(ITER, IKONVA, 1, NOPRNT)	TUPTUO	•	
246.	NOPRHT = .FALSE.	BUTPUT	ļ.	
247.	RETURN	OUTPUT	l	
248.	EMD	DUTPUT	i	
248.			l	
	· · · · · · · · · · · · · · · · · · ·	•	•	•
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FORTRAN SYMBOL	MATH 54MBDL	COD	DESCRIPTION		BLOCK	RAG	E LOC	SUBROUTIN SUBR COD	E USAGE
ATRCL	i	1	Orbital inclination	(RAD)	/0881T	/(7)	OUTPUT I	AINCL AINCL
ALPHA	a	I	Angle of attack	(RAD)	/OYNA	/(79)	AEROCO I ALGCON M AL2 I ARCIM M CONTRL M ENVPRO I MOMECO I MPLANE M OUTPUT I TRAJIN O UT I MRAPUP I	ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA ALPHA
ALT	h	1	Altitude	(FT)	/D	/(94)	OUTPUT I STATEF I WRAPUP I	ALT ALT ALT
ANOMLY	\$	1	True amomoly	(RAD)	/ORBIT	/(13)	OUTPUT I	ANOMLY
APOSEE	R.	1	Apagee radius	(FT)	/ORBIT	/(11)	OUTPUT I	APOGEE :
ARSP	ø _p	1	Orbital argument of periges	(RAD)	/ORBIT	/(8)	OUTPUT I	AR SP AR SP
AS CNOD	Ω	1	Longitude of ascending node	(RAD)	/ORBIT	/(9)	OUTPUT 1 PDBCQL M	ASCMOD ASCMOD
CD	c ^D	1	Drag coefficient		/DYNA	/(192)	AEROCO O OUTPUT I UT I	CD CD CB
CL	נר	1	Lift coefficient		/DYNA	/(186)	AEROCO M OUTPUT I UT I	CF CF CF
COD	c 0 \$ 5 E	1	See symbol		/DYMA	/(153)	DL2 I OUTPUT I TH3 I UT M	COB COD COB
COSA	COSO	ī	See symbol .		/DYNA	/(10)	AL1 I AL4 I AL4 I AL7 I AL8 I AL9 I APPLY I CONTRL I MLDRV I OUTPUT I TH3 I UT M	COSA COSA COSA COSA COSA COSA COSA COSA
COSGAM	C D S 7	1	See symbol		/DYMA	/(4)	AL1 I AL4 I AL7 I AL9 I CONTRL I NLDRV I OUTPUT I POBCQL I STATEF M	COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM
COSPHI	cos∲	1	See symbol		/DYNA	/(93)		COSPHI COSPHI COSPHI COSPHI COSPHI COSPHI

FORTRAN SYMBOL	MATH Symbol	CODE	DESCRIPTION		BLOCK	LUC	SUBROUTI SUBR CO
COSRHO	C 0 \$ p	1	See symbol		/DYNA /	/(97)	AL4 I AL7 I AL8 I AL9 I CONTRL I NLDRY I OUTPUT I POBCOL I STATEF
CS	•	ı	Speed of sound	(FT/SEC)	/DYNA	/(161	BUTPUT I STATEF I
OB.	0,	1	Base drag	(LBS)	/DYWA /	/(163:	AL1 I AL4 I AL6 I AL8 I AL9 I APPLY I CONTRL I NUBRY I STATEF I TM3 I UT I
BELTAE	^{\$} E	1	Engine deflection	(RADS)	/DYNA /	, 1551	ALGCON M ARCIN M CONTRL M DL1 I OUTPUT I TRAJIN O UT
DRAS	D	1	Aerodynamic drag	(LBS)	/DYNA /	(691	AL5 I AL7 I AL8 I AL9 I APPLY I COMTRL I ENVPRG I MLORY I OUTPUT I TH3 II
ECC	e	1	Orbital accentricity		/ORBIT /	(6)	OUTPUT I
ENERGY	E	t	Energy		/ORBIT /	(17)	OUTPUT I
GAM	,	ı	Relative flight path angle.	(RAD)	/0 /	'(92)	ARCIM I ENVPRO I OUTPUT I STATEF I WRAPUP I
GAMI	71	1	Inertial flight path angles	(RAD)	ORBIT /	(2)	OUTPUT I
6 m	GM	I	Product of Newton's universal gravitation constant and the mass of the earth.	el (FT ³ /SEC ²)	/GLOBAL/	(67)	OUTPUT I POBCQL I STATEF I
GR	9-	I	Gravitational acceleration at surface of	the earth. (FT/SEC ²)	/GLOBAL/	(1)	AL5 I APPLY I BRANPT I COSTAB I COSTAB I INTRPT I I POBCQL I POBCQL I SALVE I STATEF I TH3
10 NOV 72	6.01-47		-				

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FORTRAN SYMBOL	MATH SYMBOL	COD	DESCRIPTION -	<u>51</u> 8100	QRAG (E LOC	SUBROUT SUBR C	INE USA
HANTA	н	1	Accentus	/DR811	/(18)	OUTPUT	I HMNT
MT	υ	1	Heating (BTL		11		POBCOL OUTPUT	M HMN1 I HT
EATM	-	ī	Atmosphere option flag	/ARCDA	T/C	7)	MLDRY	I IAT
IPFLG1		1	IPFLGI#O supresses print-out of velocity losses an inertial Euler angles.	d /GLOBA	L/(69)	OUTPUT POBCQL QLTOSZ SALVE	I IPFI I IPFI O IPFI
IPFLG3		1	IPFLG3≠0 supresses print-out of impact data.	/GLOBA	L/(71)	OUTPUT OLTOSZ	
ITER		1	OL iteration number.	/CNTRL	. /€	2)	ETIME	M ITER
JAER		1	Aerodynamic model aption flag	/ARCOA	176	9)	AEROCO ARCIN OUTPUT STATEF	I JAEF I JAEF I JAEF
13		1	Angle of attack option fing. J3 = 1: Optimal angle of attack; J3 = 2: Constant angle of attack; J3 = 3: Untrimmed lift limit; J3 = 4: Vertical rise or pitchover; J3 = 5: Unpowered total acceleration limit; J3 = 6: Gravity turn; J3 = 7: Dynamic pressure constraint; J3 = 8: Heating rate constraint; J3 = 9: Reynolds number constraint.	/DYMA	/(175)	ARCIM CONTRL NPLANE OUTPUT	M J3
KONVER		I	Logical flag that indicates to the QL module that the QL iteration is converged.	/CNTRL	. #	28)	ARCIN COHOMO GROPE	I KON' O KON' O KON' I KON' I KON'
LSAM	λ,	I	Relative flight path angle costate	/D	K	101)	ARCIN CONTRL NLDRY	I LGA
LIFT	L	1	Aerodynamic lift (LBS) /DYNA	/(60)	AL4 AL5 AL6 APPLY CONTRL ENVPRQ OUTPUT TH3	I LIFT I LIFT I LIFT I LIFT I LIFT I LIFT
LM	λ _s	1	Mass costate	/0	/(106)	NLDRV OUTPUT	I LM I LM I LM
L M U	λ _p	1	Relative longitude costate	/0	/(105)		I LAU I LAU
LPSI	λ,	1	Relative azimuth angle costate	/0	/(102)	ALI ARCIN CONTRL	I LPSI I LPSI I LPSI I LPSI

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		BLOCK	0 R 4 I	GE LOC	SUBA CODE	USAGI
· · · · · ·									
LR	$\lambda_{\mathbf{R}}$	I	Altitude costate		/0	/(103)	NLDRV I OUTPUT I Wrapup I	LR LR LR
LRHO	λ_{ρ}	1	Latitude costate		/0	/(104)	NLORY 1 OUTPUT 1 WRAPUP 1	LRHO LRHO LRHO
LTAU	λ,	1	Subarc duration costate		/0	/(107)	DUTPUT 1 WRAPUP 1	LTAU
LV	λ,	1	Relative velocity costate		/D	/(100)		LV LV LV LV
n	•	I	Mess	(6'5)	/0	11	97)	AL4 I AL7 I AL8 I AL9 I APPLY I BRAMPT I COSTAB I COSTAB I INTRPT I NUTRPT I NUTRPT I SALVE I STATEF I STATEF I	******
TACH	M	1	Mach number		/DYNA	/(26)	AEROCO I ENVPRO I OUTPUT I STATEF M	MACH MACH MACH MACH
1 U	μ	1	Relative iongitude	(RAD)	/0	/(96)	OUTPUT I POBCOL I WRAPUP I	MU MU MU
KOPRNT		n	Not used.		/CNTRL	/(29)	OUTPUT M SALVE O TRAJIN O	NOPRN' NOPRN' IPRNT
•	Pr	1	Semi-latus rectum	(FT)	/ORBIT	/(5)	OUTPUT I	P P
PA	P _a	1	Atmospheric pressure	(LBS/FT ²)	/DYNA	/(14)		PA PA PA
PERGEE	R	1	Perigee radius	(FT)	/ORBIT	/(12)	OUTPUT I	PERGE
PHI	•	1	Bank angle	(RAD)	/DYNA	/(80)	CONTRL M OUTPUT I WRAPUP I	PHI PHI PHI
> \$1	*	1	Relative azimuth angle.	(RAD)	/0	/(93)	OUTPUT I STATEF I WRAPUP I	PSI PSI PSI
PSII	$\Psi_{\mathbf{I}}$	I	Inertial azimuth	(RAD)	/ORBIT	/(3)	OUTPUT I	PSII PSII
1	q	I	Dynamic pressure	(LBS/FT ²)	/DYNA	/(27)	ENVPRO I OUTPUT I POBCOL I STATEF M UT I	0 0 0 0
R MO	ρ	1	Latitude	(RAD)	/0	/(95)	AL9 I OUTPUT I STATEF I WRAPUP I	RHO RHO RHO RHO



SYMBOL	MATH Symbol	COD	DESCRIPTION	V	BLOCK	RAGE	.0C	SUBR (1 ME	E USA
10	Pa	1	Atmospheric density	(SLGS/FT ³)	/DYNA	/(15)	AL7 AL8 AL9 NLORV OUTPUT PDBCQL STATEF	I I	RO RO RO RO RO
CROSS	s _c	1	Cross range	(FT)	/ORBIT	/(149)	OUTPUT PDBCQL		SCRO
DOWN	Sp	1	Down range	(FT)	/ORBIT	/(148)	OUTPUT PDBCQL		S D O
10	sins _E	1	See symbol		/GYNA	/(154)		I I I	\$10 \$10 \$10 \$10
SINA	sina	1	See symbol		/DYNA	/(9)	AL1 AL4 AL6 AL7 AL8 AL9 APPLY CONTRL OUTPUT TH3 UT	1 1 1 1 1 1 1 1	SING SING SING SING SING SING SING SING
INPHI	sin≠	I	See symbol		/DYNA	/(92)	CONTRL	I	SING SING SING SING
INRMO	sinp	I	See symbol		/DYNA	/(96)		I I I I I	SINI SINI SINI SINI SINI SINI SINI SINI
MIMAJ	a ₆	I	Semi-major axis	(FT)	/ORBIT	/(10)	OUTPUT PDBCQL		SAI
101	S _T	1	Total range	(FT)	/ORBIT	/(158)	OUTPUT POBCOL OLTOSZ	0	510 510 510
	Ť	1	Thrust	(185)	/ DYNA	Λ.	42)	ARCIN CONTRL DL2 IMPULS OUTPUT TH1 TH2 TH3	I I I I I I I I I I I I I I I I I I I	
IAU	7	1	Subarc duration	(SEC)	/D	/(98)	ARCEN	I M I J	TAU TAU TAU



SYMBOL	MATH Symbol	CODI	DESCRIPTION		BLOCK	ORAGE	LOC	SUBROUT!	DE VAR
TIME		1	Trajectory-time ((SEC)	/DYNA	, r	2)	ENVPRO 1 OUTPUT 1 POBCOL 1 STATEF 1	TIME TIME
v	V	1	Relative velocity. (FT/	(SEC)	/0	/(91)	AL1 AL9 AL7 ALB BCOND BNORY CONTRL ENOPT ENVPRO INTERP NLORY NLORY OUTPUT NCORTEL MRAPUF MRAPUF	V V V NOM NOM NOM V V V NOM NOM V V V V V V V V V V V V V V V V V V V
VI.	٧ ₁	1	Inertial velocity (FT/	SEC)	/ORBIT	/(1)	OUTPUT I PDBCQL I PDBCQL I	DRBPR
AMU	μ _*	1	Atmospheric viscosity (dynamic) (SLGS/FT/	(SEC)	/DYMA	/(214)	OUTPUT I	
u	W		Weight	LBS)	/DYNA	/(91)	ALS I ENVPRO I OUTPUT I PDBCQL I QLTOSZ I STATEF I TH3	W W W W W W W W W W W W W W W W W W W
XJ	j	I	Control blend factor		/DYNA	/(159)	ARCIN COLL DUTPUT I STATEF I	XJ XJ
XMCG	M _{CG}	1	Aerodynamic moment about center of gravity (FT-	-LBS)	/DYNA	/(160)	QUIPUT 1	
XMUI	μ_{1}	i	Inertial longitude (RAD)	/ORBIT	/(4)	OUTPUT I	
XX		I	Fraction of subarc that has transpired		/DYNA	/(1)	ARCIN CERROR I	XX
1	Z	1	A 20 word array used to store the total linear solution from the preceding QL iteration.		/1	/(1)	BNDRY 1 BRANPT 1 ENDPT 1 INTERP 0 INTERP 1 INTER	1

10 NOV 72 G.01-47

.



FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	<u>\$</u> BL0	TORA CK	GE LOC	<u>SUBRDU</u> SUBR			
20		1	A 20 mord array containing the vector $f(X,Z,M)$ in Equation 17.1-7 in Vol.1 of this document.	/20	/(1)	ENVPRO LINDRY OUTPUT AKUTTZ WRAPUP	I	20 20 20 20 20	

SUBRØUT I NE PDBCQL



Purpose

PDBCQL computes all functional target conditions and their partials with respect to the state.*

^{*}See documentation for Subroutine PDBC in the Steepest Descent module



```
PDBCQL
  1.2345.61.84.
                                                                                                                   DYNA
DYNA
DYNA
                                                                                                                   DYNA
DYNA
DYNA
DYNA
DYNA
                                                                                                                   JUL21
DYNA
                                                                                                                   DYNA
DYNA
DYNA
24.
26.
27.
28.
30.
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DYNA
DYNA
DYNA
DYNA
DYNA
DYNA
DYNA
32.
33.
                                                                                                                   DYNA
JUL21
34.
35.
36.
                                                                                                                   JUL21
AUGO9
GLOBAL
GLOBAL
GLOBAL
ARCDAT
ARCDAT
ARCDAT
              40.
41.
42.
43.
ARCDAT
ARCDAT
ARCDAT
                                                                                                                   ARCDAT
              JUL 21
                                                                                                                   POBCOL
       00000000000000000
                    THIS SUBROUTINE COMPUTES FUNCTIONS OF STATE AND PARTIALS FOR VARIOUS PURPOSES IN TABTOP ++ DEFINITIONS++
                                                                                                                   PDBCQL
PDBCQL
PDBCQL
PDBCQL
                             VARIABLE CODE NUMBER
VALUE OF FUNCTION
PARTIAL DERIVATIVE ARRAY
TIME DERIVATIVE OF F
                                                                                                                   PDBCQL
PDBCQL
PDBCQL
                          POBCOL
                                                   COMPUTE F DNLY

1 = COMPUTE S

2 = ESTIMATE SD IF POSSIBLE

3 = COMPUTE SD
                                                                                                                   POBCOL
POBCOL
POBCOL
POBCOL
                               OPTION FLAG =
                                                                     REDUNDANT COMPUTATION
                                                                                                                   PDBCQL
PDBCQL
PDBCQL
                    ISKP = BYPASS FLAG TO INHIBIT
                DIMENSION S(1),F(1)
```

```
COMMON/ ORBIT/ VI
* ECC, AINCL,
* PERGEE, ANORLY,
* HMNTM, DVIDM,
* DVIDM, DVIDM,
* DVIDM, DVIDM,
* DPIDV, DPIDG,
* DPIDMU, DMIDMU
                                                                                                                                                                                                           GAMI,
ARSP,
CAPX,
DVIDG,
DVIDPS,
DGIDM,
DPIDH,
DMIDG,
DPDW,
             76.
77.
78.
79.
                                                                                                                                                                                                                                                                                                                                , IUMX
, LARIRS
, ANYSA
                                                                                                                                                                                                                                                                                 PSII,
                                                                                                                                                                                                                                                                                                                                                                                        APOGEE,
ENERGY,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ORBIT
                                                                                                                                                                                                                                                                      ASCNOD CAPY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ORBIT
ORBIT
ORBIT
                                                                                      DYIDH,
DGIDG,
DPIDV,
DPIDMU,
DMIDRO,
                                                                                                                                                                                                                                                            DVIDRO,
DGIDPS,
DPIDM,
DMIDM,
DPDG,
DECDV,
DECDMU,
DIDRO
DBEDPS,
NNORM,
                                                                                                                                                                                                                                                                      DVIDRO.
                                                                                                                                                                                                                                                                                                                                DVIDAU.
                                                                                                                                                                                                                                                                                                                                                                                               DGIDV.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ORBIT
           80.
81.
82.
83.
                                                                                                                                                                                                                                                                                                                                                                                       DGIDY,
DGIDMU,
DPIDMO,
DMIDPS,
DPDM,
DECDH,
DIDG,
DBEDV,
OBEDMO,
                                                                                                                                                                                                                                                                                                                               DGIDRO,
DPIDPS,
DRIDR,
DPOM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ORBIT
ORBIT
                                                                                                                                                       DAIDAÚ,
                                                                                                                                                                                                                                                                                                                        DPOM , DECDG , DIDMU , DBEDRÓ ,
                                                                                                                                                                                                   DPOV
DPDMU
DECDRO,
DIDPS
DBEDM
DNODH
                                                                                                                                                      DMIDMU,
DPDRO
DECDPS,
DIDM
DBEDH
DNODG
DSMDV,
                                                                                      DPDPS,
DECDM,
DIDM,
DBEDG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                BRRIT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ORBIT
ORBIT
ORBIT
ORBIT
           86.
87.
88.
89.
90.
91.
                                                                           DBEDG DBEDM
DNODY DNODG
DNODMU DSMOV
COMMON/ORBIT/
DSMDRO, DSMDMU
DAPDPS, DAPDRO
                                                                                                                                                                                                                                                                    DNODM ,
DSMDH,
                                                                                                                                                                                                                                                                                                                              DNODPS,
DSMDM,
                                                                                                                                                                                                                                                                                                                                                                                        DNDDAD,
DSMDPS
                                                      - DANDDW DANDDW DANDDW DANDDW DANDDW DANDDW DANDDW DANDDW COMMON/DAST/
- DANDDW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ORBIT
ORBIT
ORBIT
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                                                                                                                                                                                                                                                                       DAPDG,
DPEDAU,
DPEDAU,
DANDRO,
DCYDM
DCYDM
DASDH,
DENDG
DMODV
DMODV
                                                                                                                                                                                                                                                                                                                                  DAPDH,
DPEDG,
DANDY
DANDHU,
DCXDRO,
                                                                                                                                                                                                                                                                                                                                                                                      DAPDM ,
DPEDH ,
DANDG
DCXDV ,
DCXDMU ,
DCYDRO ,
DASDPS ,
DENDM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DRAIT
           94:
95.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ORBIT
ORBIT
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ORBIT
           96.
97.
98.
99.
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ORBIT
ORBIT
        100.
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       101.
102.
103.
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ORBIT
ORBIT
ORBIT
       104,
105,
106,
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                              PDBCQL
       100.
100.
110.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PDBCQL
PDBCQL
PDBCQL
PDBCQL
PDBCQL
PDBCQL
PDBCQL
      113:
        114.
      11>.
       110.
117.
118.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             POBCOL
PDBCOL
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PDBCOL
       119.
         20
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POBCOL
POBCOL
       121.
        123
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      124.
125.
126.
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PDBCOL
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       124
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PDBCOL
      124.
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         31
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              PDBCOL
       132.
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PDBCOL
PDBCOL
      134,
135,
136,
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PDBCOL
PDBCOL
      130,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PRACOL
     140.
141.
142.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            POBCOL
POBCOL
POBCOL
   143.
144.
145.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PDBCOL
POBCOL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            POBCOL
148.
149.
                                                      10 CONTINUE
1F(KK.GE.30) GO TO 530
PARAMETER IS AMONG ORBITAL SET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           PD8COL
PD8COL
PD8COL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          530
```

								1
	C	TEST FOR ESTIMATE OPTION	PDBCQL			<u> </u>		
2. 3.		K=KK-11 1F(10P.EQ.0) 60 TO 20	PDBGQL PDBCQL	20-				1
١.	C	TEST FOR PARAMETER CALCULATION ONLY K=18+K	POBCOL PD6COL	1	ĺ			1
5.	20	IF(15KP.EQ.0) 60 TO 40	POBCOL	40-	"	l		l .
Ι.	30	MM=AND(JVAR(K),-MS(ISKP))	POBCQL	'`				1
3.		IF(MM.NE.O) GÓ TO 50 IF(K-18)230,230,420	PBBCQL PBBCQL	١,	50-	230-	120-	,]
١.		MM = JVAR(K)	POBCOL	1-	,	ł		1
<u></u>	<u>C</u>	TEST AND COMPUTE VI	POBCOL	.		ľ	1 1	
2.	50	1F(0.EQ.AND(MM,MSK1)) GO TO 60 VE = R+DMEGA+CÓSRHO	PDBCQL PDBCQL	60-	1		1 1	
3. 		VI= SQRT(V+V +2.*VE+V*COSGAM*SINPSI+VE*VE) 1F(MM.LT.MSK2) BD TO 230	- PDBCQL PDBCQL	1	230		1 1	
•	С	TEST_AND COMPUTE GAMMA INERTIAL AND ITS TRIG FUNCTIONS	POBCOL] ;	. 30		}	
7 . 3 .	60	IF(AND(mm, msk2).Eq.0) GO TO 70 SNG1 = V*SINGAM/VI	PDBCQL	70-	i			i
).		GAMI = ASIN(SNGI)	PDBCQL	i i	ĺ		((Ĭ.
١.		CSGI = SORT(1 SNGI+SNGI) ISKP =1	PDBCQL PDBCQL	1	l		(l	l
	•	1F(MM.LT.MSK3)GO TO 230	PDBCQL	l	230			l
	C 70	TEST AND COMPUTE PSI INERTIAL AND ITS TRIG FUNCTIONS IF(AND(MM, MSK3).EQ.O) GO TO 80	POBCOL	80-	Ţ			1
•	. •	SPSII=(V+COSGAM+SINPSI+VF)/(VI +CSGI)	POBCOL	""			l I	1
		PSII = ATAN2(V+COSGAM+SINPSI+VE ,V+COSGAM+COSPSI) CPSII= COS(PSII)	PDBCQL PDBCQL			1	ľ	Ţ
	-	ÎSRP =2 ÎF(MM,LT.MSR4) 60 TO 230	POBCOL	1	230-		-	1
٠.	С	TEST_AND COMPUTE MU IMERTIAL	PD8COL PD8COL	1.	230		}	ł
	80	IF(AND(MM, MSK4).EQ.0) 60 TO 90	POBCOL	90-]	1
		XMUI≈ MU+ ÔMGZ+TIME IF(KK .LT. 0 .AND. IPFLG1 .NE. 0) GO TO 540	PDBCQL PDBCQL	Į į				540
	c	IF(MM.LT.MSK5) 60 TO 230 TEST AND COMPUTE SEMI-LATUS RECTUM	PDBCQL PDBCQL		230-			ŧ
	<u> </u>	IF(AND(MM,MSK5).EQ.Q) GO TO 100		100-	_			1
		P= R+R+ Vi=Vi+ CSGI=CSGI /GM IF(MM.LT.MSK6) GO TO 230	PDBCQL PDBCQL		230		ł	ł
, . L	С	TEST AND COMPUTE ECCENTRICITY	PDBCOL		1.30		1	l
١	100	1F(AND(MM, MSK6).EQ.0) GO TO 110	POBCOL	110-	รี]
•		Rv20mu = `R*vI*vI/6m ECC= SQRT(1 Rv20mu*(2Rv20mu)*CSGI*CSGI)	POBCOL Pobcol		1		1	1
	C	IF(MM.LT.MSKT) GO TO 230 TEST AND COMPUTE INCLINATION AND ITS TRIG FUNCTIONS	POBCOL PDBCOL		230			ſ
-		IF(AND(MM,MSK7).EQ.0) GO TO 120	POBCOL	120-	₹ .			ł
		CSI= COSANO* SPSII AINCL = ACOS(CSI)	PDBCQL PDBCQL		1			I
:		SNI = SIN(AINCL)	PDBCQL	1	1		J	1
٠	С	IF(MM.LT.MSK8) GD TO 230 TEST AND COMPUTE ARG. OF PERIGEE	PDBCQL PDBCQL	l	230			I
		IF(AND(MM.MSKB).EQ.O) 60 TO 130	PDBCQL	136-	₹			1
		CSGNU =(P'-R)/R/ECC IF(ABS(CSGNU) .GT. 1.) CSGNU = SIGN(1., CSGNU)	PDBCQL PDBCQL	ĺ	1			I
		GNU = ACDS(CSGNU)	POBCOL	l	1	I		
:		SROI = SINRHO/SNI IF(ABS(SROI).GT.1.)	PDBCQL PDBCQL	ľ	1	j		1
		ARGP = ASIN(SROI) - GNU IF(MM.LT.MSK9) GD TO 230	PDBCQL PDBCQL		230		1]
	С	TEST AND COMPUTE LONG. OF ASCENDING NODE	PDBCQL	L	1			l
:	130	IF(AND(MM, MSK9).EQ.O) GO TO 140	PDBCQL PDBCQL	140-	า ี	- (Í
		SPSI = SPSII+SINRHO/SNI IF(ABS(SPSI).GT.1.) SPSI= SIGN(1.,SPSI)	POSCOL	ł	1	1		l
		ASCNOD = XMUI - ASIN(SPSI) IF(MM.LT.MSK10) GO TO 230	POBCQL POBCQL	ļ	230		.]	1
	С	TEST AND COMPUTE SEMI-MAJOR AXIS	PDBCOL	_	1-30]
•	140	IF(AND(MM,MSK10).EQ.0) GO TO 150 SMIMAL= R+GM /(2.+GM -R+VI+VI)		150-	์ า	1	- 1	}
		IF(MM.LT.MSK11) 60 TO 230	PDBCQL	Ì	230		- 1	ĺ
:	C	TEST AND COMPUTE APOGEE	POBCOL		1 .			1

			1 15
]]]
		1	
			1 11
0. 150 1F(AND(MM, MSK11).EQ.0) GD TO 160 1. APOGEE= SMIMAJ+(1.+ECC)	PDBCQL PDBCQL	160-	1 11
2. 1F(MM LT.MSK12) GO TO 230	PDBCQL	230-	- ↓
3 C TEST AND COMPUTE PERIGEE	POBCOL	فيي	1 11
4. 160 IF(AND(MM, MSK12).EQ.O) GO TO 170 5 PERGEE = SMIMAJ*(1ECC)	PDBCQL	770	-
6 1F(MM.LT.MSK13) GO TO 230	PDBCQL	230-	
7. C TEST AND COMPUTE TRUE ANDMOLY	POBCOL	ر ر	1 11
8. 170 IF(AND(MM, MSK13).EQ.O) 60 TO 180 9. ANDMLY = ATAN2(SNGI/CSGI, 1 R/ P)	PDBCQL PDBCQL	180	1 11
O. IF(MM.LT.MSK14) GO TO 230	PDBCQL	230-	-
1. C TEST AND COMPUTE CAP X 2. 180 1F(AND(MM,MSK14).EQ.0) 60 TO 190	PDBCQL PDBCQL	190 -	-
CAPX = P/ECC	POBCOL	1]]].
IF(MM.LT.MSK15) GO TO 230 C TEST AND COMPUTE CAPY	PDBCQL PDBCQL	230	
6. 190 1F(AND(MM_MSK15).EQ.O) GO TO 200		·	-
7. CAPY = P*ECC / SQRT(ECC+ECC -1)	POBCOL	i	,]]
8. IF(MM.LT.MSK16) GO TO 230 9. C TEST AND COMPUTE ASSYMPTOTE	PDBCQL PDBCQL	230-	-
0 200 1F(AND(MM, MSK16).EQ.0) 60 TO 210		10=	1 11
1. ASYMP = ACOS(1./ECC)	PDBCQL	1]]]
IF(MM.LT.MSK17) GO TO 230 TEST AND COMPUTE ENERGY	POBCOL POBCOL	230-	7
4. 210 IF(AND(MM. MSK17).FD.D) 60 TO 220		20-	1 11
5. ENERGY = ^ 2.+GM / SMIMAJ	POBCOL	220-	_]]]
6IF(MM.LT.MSK18) GO TO 230 7. C TEST AND COMPUTE MOMENTUM	PDBCQL PDBCQL	230-	ㅋ ॥
8 220 1F(AND(MM.M5K18).EQ.O) 60 TO 240	POBCOL 2	40=	1 11
9. HMNTM= Å*VI*CSGI D 1F(MM.GE.MSK19) GD TO 240	PDBCOL 2	40-	1 11
. IF(KK.LT.0) 60 TO 540	PDBCOL	. ""	540
C RETURN REQ. ORB. PARA. THROUGH ANG. LIST	PDBCQL		
3 230 F = ORBPRM(K) 4 RETURN	PDBCOL PDBCOL		11
5 C TEST AND COMPUTE PARTIALS OF V INERTIAL	PDBCOL	}	[]
6. 240 IF(AND(MM,MSK19).E0.0) GO TO 250 7. DVIDV =(V+R+OCORHO+COSGAM+SINPSI)/VI	PDBCQL 2	50	f i
7. DVIDV =(V*R+OCORHO+COSGAM+SINPSI)/VI 8. SNGI=V*SINGAM/VI	POBCOL	i	H
7.	POBCOL POBCOL		††
P DVIDM =0.	PDBCQL	į	H
2. DAIDDO - CIMBMONDEN ACCOUNTERNACT AES / (LUCENUENT)	PDBCQL PDBCQL	1	
. DAIDWA O.	PDBCQL	1	<u> </u>
TECT AND COMPUTE DARTIALS OF CAMMA IMPRITAL	PDBCQL POBCQL	1420-	
7. 250 IF(AND(MM_MSK20).EQ.0) 60 TO 260			11
3. VICI = VI+ CSGI	POBCOL		IJ
). TMQ= - v+ SINGAM/(VI+ VIC1)). DGIDV ≈ SINGAM/VICI + TMQ+DVIDV	PDBCQL PDBCQL		11
i. DGIDG ≈ V+COSGAM/VICI + TMQ+DVIDG	POBCOL	ł	
?. DGIDH ≈ TMQ+DVIDH . DGIDM=0.	PDBCQL	ł]]
OGIOPS= TMQ+ DVIOPS	PDBCQL	1	[]
. DCIDMI~V	POBCOL POBCOL	Ì	11
IF(MM.LT.MSK21) GO TO 420	PDBCQL PDBCQL	420	
C TEST AND COMPUTE PARTIALS PSI INERTIAL 260 IF(AND(MM,MSK21).EQ.O) GO TO 270		70-	. 11
D. TM1= CPSI1+CPSI1 /(V+COSGAM+COSPSI)	POBCOL	· · ·	11
1.	PDBCQL POBCQL	}	- 11
DPIDG= DPIDH+R+SINGAM/COSGAM	PDBCQL		11
PPIDPS:	PDBCQL PDBCQL	[
	PDBCOL	į	
' DP1DRD= -R*DAG2*SINRHO*T#1			
	POBCOL	- }	1 1

9.	IF(MM.LT.MSK22) GO TO 420	PDBCDL	1	420
о с	TEST AND COMPUTE PARTIALS OF MU INERTIAL	PDBCOL	1.	1740
1 27	0 IF(AND(MM, MSK22).EQ.0) GO TO 280	PDBCQL	280-	ว์
2. 3.	OMIDY =0. Omidg =0.	POBCOL Pobcol	1	j
₩.	DMIDH =0. DMIDM =0.	PDBCQL PDBCQL	1	}
ns •••	DMIDPS=0.	PDBCQL	1	
1.	DMIDRO=0. Dmidmu=1.	PDBCQL PDBCQL	1	1
⊌. 9	IF(MM.LT.MSK23) GO TO 420	POBCOL	Ì	420
	TEST AND COMPUTE PARTIALS OF SEMI-LATUS RECTUM	PDBCOL		ł
1 28 2.	0 IF(AND(MM,MSK23).E0.0) 60 TO 290° TM2= 2.+ P /VI	POBCQL Pobcql	290-	1
3.	TM3= 2.4 P-/ R	PDBCQL	1	1
٠.	TM4=-2.*P/CSGI *SNGI DPDv= TM2*DvIDv + TM4*BG1Dv	PDBCQL PDBCQL	1	
. •.	DPDV= TM2*DVIDV + TM4*DGIDV DPDG= TM2*DVIDG + TM4*DGIDG	POSCOL	ļ,	
1.	DPDH= TM3 + TM2+DVIDH + TM4+DG1DH DPDM= 0.	PDBCQL PDBCQL	1	
g. 9.	OPDPS= Tm2*DVIDPS + Tm4*DGIDPS OPDRO= Tm2*DVIDRO + Tm4*DGIDRO	PDBCQL PDBCQL	ļ	
0. 1.	DPDmu= 0.	PDBCQL		
2.	IF(MM.LT.MSK24) GO TO 420 TEST AND COMPUTE PARTIALS OF ECCENTRICITY	PDBCQL PDBCQL	1	420
) IF(AND(MM,MSK24).EQ.0) 60 TO 300	PDBCQL	300-	7
5.	TMM= (RV20MU -1)*RV20MU*CSGI*CSGI/ECC	PBBCOL		
٠.	TM5= 2.*TMM/VI _TM6 = RV2OMU*(2. ~ RV2OMU) * C5GI* SNGI/ ECC	POBCOL PDBCOL	1	
/ . ¥ .	TM7 = TMM/ R	" PDBCQL]	
٠.	OECOV= TM5+DV1DV + TM6+OG1DV DECDG= TM5+DV1OG + TM6+OG1DG	PDBCQL PDBCQL	1	
0. 1.	DECDH= TM7+ TM5+DVIDH + TM6+DGIDH	PDBCOL	, 1	
3:	DECDM=0. DECDPS=TM5*DV1DPS + TM6*DGIDPS	PDBCQL PDBCQL]	
4.	DECDRÓ=TM5+DVIDRÓ + TM6+DGIDRÓ	POBCOL		
• •	DECDMU= 0. 1F(MM.LT.MSK25) 60 TO 420	PDBCQL PDBCQL		420
. с	TEST AND COMPUTE PARTIALS OF INCLINATION	POBCOL	لسها	•
8. 301 9.) IF(AND(MM,MSK25).EQ.O) GD TO 310 TM8 = -COSRHO+ CPSII /SNI	PDBCQL PDBCQL	310-	
ó.	DIDV= TM8+DPIDV	POBCOL		ı
1.	D106= TM8+DP106 D1DH= TM8+DP10H	PDBCQL PDBCQL	1	
2. 3.	DIDM= 0.	PDBCOL]	
4 .	DIOPS= TM8+OPIOPS DIDRO= SINRHO+SP5II /SNI + TM8+DPIDRO	PDBCQL PDBCQL]	
	DIDAU= 0.	PDBCQL		420
c c	IF(MM.LT.MSK26) GO TO 420 TEST AND COMPUTE PARTIALS OF ARG. OF PERIGEE	PDBCQL PDBCQL	, ,	120
) IF(AND(MM, MSK26).EQ.0) GO TO 320	PDBCQL	320-	
).	CGNAR = (COS(GNU +ARGP) SNGNU = SIN(GNU)	PDBCQL PDBCQL	1	
1. 2.	DGNDP= -1./(R*ECC*SNGNU)	PDBCQL		
3.	DGNDR = -P*DGNDP/ A DGNDE = -(P-R)/ECC *DGNDP	PDBCQL PDBCQL		
1 .	TM9 = - SINRHO+CSI/SNI/SNI/CGNAR	POBCOL		
	DBEDV =-OGNDP*DPDV - DGNDE*DECDV + TM9*DIDV DBEDG =-DGNDP*DPDG - DGNDE*DECDG + TM9*DIDG	PDBCGL PDBCGL	[]	
• .	DBEDH = -DGNDR -DGNDP+DPDH -DGNDE+DECDH + TM9+DIDH	PDBCQL		
₽ .	DBEDM = 0. DBEDRO= COSRHO/(SN1+CGNAR)-DGNDP+DPDRO -DGNDE+DECDRO +TM9+D1DRO	PDBCQL PDBCQL		
). I.	DBEDPS= -DGNDP+DPDPS -DGNDE+DECDPS +TM9+DIDPS	PDBCQL	1 1	
2.	DBEDAU= 0. IF(AM.LT.ASK27) GO TO 420	PDBCQL PDBCQL		420
3. c	TEST AND COMPUTE PARTIALS OF LONG. OF ASCENDING NODE	POBCOL		
	1F(AND(MM, MSK27).EQ.O) GO TO 330	PDBCQL	330	
	CDNO =-COŚ(ASCNOD -MU- OMGZ*TIME) DNODPI = CPSI; *SINRHO/(SNI*COND)	PDBCQL PDBCQL	l l	
• .	DNODRA = SPSII+COSRHO/(SNI+CONO)	POBCOL PDBCOL	 	
}. – ~	DNODI = - SPSII+SINRHO+CSI /(SNI+SNI+CDNO) DNODV = DNODPI+DPIDV +DNODI+DIDV-	POBCOL		
).			, ,	

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.1	DNODG = DNODP1*DPlDG +DNODI*DIDG	POBCOL	1	
2.	DNODH = DNODPI+DPIDH +DNODI+DIDH	POBCOL	1	
3.	DNODM =0. DNODPS=DNODPI*DPIDPS +DNODI*DIDPS	PDBCQL Pobcql	1	
4. 5.	DNODRO= DNODRR +DNODPI+DPIDRO + DNODI+DIDRO	PDBCOL		
6.	DNODMU= 1.	PDBCQL		
1.	IF(MM.LT.MSK28) 60 TO 420 Test and compute partials of smimaj	PDBCQL PDBCQL	420-	
9 33	0 IF(AND(MM,MSK28).EQ.0) GD TO 340	PDBCQL 340		
7 0. C	TEST FOR MOMENTUM	POBCOL	7	
1.	IF(K.EQ.36) GO TO 410	PDBCOL	410-	٦ .
2.	DSMDR = SMIMAJ/R*(1. + SMIMAJ*VI*VI/GM) DSMDVI= 2.*SMIMAJ*SMIMAJ*VI/GM	PDBCQL PDBCQL	1	1
3.	DSWDA1 = DSWDA1 + DA1DA	PDBCQL	1	ł
♥ . > .	DSMPG = DSMDVI+DVIOG	PDBCQL		
• .	DSMDH= DSMDR + DSMDVI*DVIDN DSMDM = 0.	PDBCQL PDBCQL	1	•
1. 8.	OSMOPS= DSMOVI+ DVIDPS	POBCOL	i i	ŀ
9.	OSMORO= DSMOVI+DVIDRO	POBCOL POBCOL	ſ	1
٥. ر	DSMDMU = 0. Test for energy	POBCOL	1	1
1. 2.	1F(K.EQ.35) GO TO 400	PDBCQL	400-	1
3	IF(MM.LT.MSK29) GO TO 420 TEST AND COMPUTE PARTIALS OF APOGEE	PDBCQL PDBCQL	1 1	420-
5 34		PDBCOL 350-	ן ב	ſ
2 34 6	0 IF(AND(MM,MSK29).E0.0) 60 TO 350 Dapda = 1.+ECC	PDBCOL 330	7	
1.	DAPDE = SMIMAJ	PDBCQL !	1 1	Į.
	DAPDV= DAPDA+DSMDV + DAPDE+DECDV Dapdg =Dapda+DSMDG + Dapde+DECD6	PDBCQL PDBCQL	1 1	1
٠.	DAPDH=DAPDA+DSMDH +DAPDE+DECDH	PORCOL	.1 1	1
0. 1.	DAPOM = 0.	PDBCQL	1 1	l
2.	DAPDPS= DAPDA*DSMDPS + DAPDE*DECDPS DAPDRO= DAPDA*DSMDRO + DAPDE*DECDRO	POBCQL PDBCQL	1 1	1
3.	DAPDMU= 0.	PDBCGL	1 1	1
¥.	IF(MM.LT.MSK30) GO TO 420	POBCOL	1 1	420-
<u></u>	TEST AND COMPUTE PARTIALS OF PERIGEE	PDBCOL	ן נ	Ì
7. 3> 8	0 1F(AND(MM,MSK30).EQ.0) GO TO 360 DPEDA = 1ECC	POBCOL 360-	7 I	1
.	DPEDE = -SMIMAJ	PDBCOL	1 1	l
٠. ٥.	DPEDV = DPEDA+DSMDV + DPEDE+DECDV	PDBCQL PDBCQL	1 1	1
1.	DPEOù = DPEDA+DSMDG + DPEDE+DECDG DPEDH = DPEDA+DSMDH + DPEDE+DECDH	PDBCOL	1 1	l
2. 3.	DPEDM = 0	PDBCQL	1 1	į
- .	OPEOPS= OPEDA*DSMOPS +OPEDE*DECOPS OPEORO= OPEDA+DSMORO +OPEDE*DECORO	POBCOL POBCOL	1 1	1
• .	DPEDAU= 0.	PDBCOL	1 1	ł
,	IF(MA.LT MSK31) GO TO 420	PDBCQL	1 1	420-
ا	TEST AND COMPUTE PARTIALS OF ANOMOLY	POBCOL	ן נ	1
9 36 0.	0 IF(AND(MM, MSK31).EQ.0) 60 TO 370 CSANO = COS(ANOMLY)	PDBCQL 370-	ገ /	ł
i.	CS2 = CSAND*CSAND	PDBCQL	1	1
2.	COM = 1, - R/P	PDBCQL }	1 1	ł
3.	DANDGI = CS2/ CSG1/ CSG1/ CON DANDG = CS2*SG1/(P*CON*CON*CSGI)	PDBCQL PDBCQL	1	
	UARUP = - UANUR + K/F	POBCOL	1 1	l
• . • .	DANDY = DANDGI+DGIDY + DANDP+DPDY DANDG = DANDGI+DGIDG + DANDP+DPDG	POBCOL POBCOL	1	1
<i>'</i> .	DANDS = DANDGI+DGIDS + DANDF+DFDB DANDH = DANDR + DANDGI+DGIDH + DANDF+DFDH	POBCOL	1 1	l
	DANDM =0.	POBCOL	1 1	1
).	DANDPS = DANDGI+DGIDPS + DANDP+DPDPS DANDRO = DANDGI+DGIDRO + DANDP+DPDRO	PDBCOL PDBCOL	1 1	I
١.	DANDAU = 0.	POBCOL	1	
2. 3. c	IF(AA.LT.ASK32) GO TO 420	POBCOL	1 1	420-
<u> </u>	TEST AND COMPUTE PARTIALS OF CAPX	POBCOL	ן נ	1
37. 5.	D IF(AND(MM_MSK32).EQ.O) GD TO 380 DCXDP = 1./ ECC	POBCOL 380-	7 i	1
	DCXDE = -P/(ECC+ECC)	PDBCQL		
,	BCXDV = BCXDP+DPDV + BCXDE+DECDV BCXD3 = BCXDP+DPDG + BCXDE+DECDG	PDBCQL I	1 1	1
٠.	DCXD3 = DCXDP+DPD6 + DCXDE+DECD6 DCXDH = DCXDP+DPDH + DCXDE+DECDH	POBCOL POBCOL	1	l
ο.	BCXDM =0.	POBCOL	1	1
1. 2	DCXGPS= DCXDP+DPGPS +DCXDE+DECDP\$	PDBCQL	1 1	l
3.	-DCXDRO= DGXDP+DPDRO-+DCXDE+DECDRO	PDBCQL	-	
	-			

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1434	nevenue a	POBCOL	1					
435.	DCXDAU= 0. IF(MM.LT.A5K33) GD TO 420	PDBCQL	1		420			
436.	C TEST AND COMPUTE PARTIALS OF CAPY	PDBCOL	-			- 11		
437.	380 IF(AND(MM,MSK33).EQ.O) GO TO 390 TM1 = ECC+ECC	PDBCOL PDBCOL	390-) [l	+1		
439.	TM2 = TM1-1 SDE2 = SORT(TM2)	PDBCOL PDBCOL	1		1	- 11		
441.	DCYDP = ECC/ SQE2	PDBCQL	1			- 11		
442.	DCYDE = P/SQE2+(1 TM1/ TM2) DCYDV =DCYDP+DPDV + DCYDE+DECDV	PDBCQL PDBCQL		} }	1	- 11		
443.	DCYDG =DCYDP *DPDG +DCYDE*DECDG	PDBCOL			l	- 11		
445 .	DCYDH =DCYDP+DPDH + DCY0E+DECDH DCYDM =0	PDBCQL PDBCQL	[1	11		
446.	DCYDPS =DCYDP*DPDPS +DCYDE* DECDPS	PDBCQL	1 /	i t	1	- 11		
448.	DCYDRO_= DCYDP*DPDRO +DCYDE*_QECDRO DCYDMU = 0.	POBCOL.	+ !		1	- 11		
44 V.	1F(MM.LT.MSK34) 60 TO 420 C TEST AND COMPUTE PARTIALS OF ASSYMPTOTE	PDBCQL PDBCQL			420	\neg 1		
452	390 IF(AND(MM,MSK34).EQ. 0) 60 TO 420	POBCOL	┿┈	'	420	11		
4> 3.	SNASY = SIN(ASYMP)	POBCOL	j	J		Ш		
4>4 .	DASDE = 1./ (SWASY+ECC+ECC) DASDY = DASDE+DECDY	PDBCQL PDBCQL	1	ı		H		
456.	DASDG = BASDE*DECDG DASDH = DASDE*DECDH	PD8CQL PD8CQL	ł	- 1	1	- 11		
454.	DASDM = 0.	PDBCQL	1	1	ł	- 11		
45 4.	DASDPS= DASDE+DECDPS DASDRO = DASDE+ DECDRO	PDBCQL PDBCQL	Į.		1	- 11		
461.	DASDMU = 0.	PDBCQL	1	- 1				
462.	GO TO 420 C COMPUTE PARTIALS OF- ENERGY -	PDBCQL PDBCQL	1	ļ	420			
464	400 CONTINUE	POBCOL	1		1	- 11		
465.	DENDSM= -2.*GM / (SMIMAJ* SMIMAJ) DENDV = DENDSM * DSMDV	PDBCQL PDBCQL	1		i	- 11		
466.	DENDG = DENDSM + DSADG	PDBCQL	1		1	- 11		
468.	DENDH = DENDSM + DSMDH DENDM = 0.	PDBCQL PDBCQL			1	- 11		
4/0.	DENDPS= DENDSM + DSADPS	PDBCQL PDBCQL	1		1	- 11		
4/1.	DENDRO= DENDSA + DSMDRO Denomu= 0.	POBCOL	l		1	- 11		
4/2.	GO TO 420 C COMPUTE PARTIALS OF MOMENTUM	PDBCQL PDBCQL]	•	420	\neg 1		
475.	410 CONTINUE	PDBCQL	╆		J	- 11		
476.	DMODR=HMNTM/R	POBCOL Pobcol	1			- 11		
477.	DMODVI= HMNTM / VI DMDDGI= - R+VI + SNGI	PDBCBL	1			11		
479	DMODV = DMCDVI+DVIDG+DMODGI+DGIDG DMODG = DMCDVI+DVIDG+DMODGI+DGIDG	POBCOL Pobcol	1			- 11		
480.	DMODH = DMODR + DMODVI*DVIDH +DMODGI*DGIDH	PDBCQL	İ			- 11		
482.	DMODM =0. DMODPS =DMODVI+DVIDPS + DMODGI+DGIDPS	PDBCQL PDBCQL	l			- 11		
483. 484.	DMODRO =DMODVI*DVIDRO + DMODGI*DGIDRO DMODMU =0.	PDBCQL PDBCQL				- 11		
485.	STORE PARTIALS IN S AND COMPUTE SD	POBCOL	1			- 41		
487.	420 K=K-18	PDBCQL						
П488.	DD 430 J=1,1 Jmap = map(J)	PDBCQL PDBCQL	ì			- 1		
440.	SI IMAP) = PPA(I K)	PDBCQL	l			- 1		
441.	130 CONTINUE F = ORBPRM(K)	PDBCQL PDBCQL	ł			İ		
443.	RETURN KK.GE.30 REENTRY TYPE TARGETS	PDBCQL PDBCQL	ļ			- 1		
495.	530 K= KK-29	POBCOL	-					
496.	GO_TO (540,570,600,630,690,750,800)	POSCOL	570	7600-	1630-	7690-	7750-	180
497.	+ ,K Downrange Calculat ion	POBCOL Pobcol	ļ	1	l	}	j	
499.	540 COSOMU = COS(MU-YMXRF)	POBCOL	-	 	╁─╌	+	 	╆
500 501.	SINOMU = SIN(MU-YMXRF) TDNUM= CSPSR*(SINRHO*CSXLMR~COSRHO*SNXLMR*COSDMU)+SNPSR*COSRHO*:	PDBCQL	{	((1	1	1
502	1 DMU	PDBCOL	Į.	1	1	1	1	1
>03.	TDDEN= SINRHO+SNXLMR +COSRHO+CSXLMR+COSDMU TD = ATAN2(TDNUM,TDDEN)	PDBCQL PDBCQL	ŀ	1		1	1	l
204. 202.	SDOWN =TD+ER	POBCOL	F					1-

					-					۱
					1					1
6.		IF(KK.LT.0) GO TO 580	PDBCQL	580-	٦				1	l
7. 8. C		F= TD*ER PARTIALS OF DOWNRANGE	PDBCQL PDBCQL	Į .	Ш		Į		1	1
9		COSTD = COS(TD)	PDBCQL	1	Ш			1	1	
0. i.		S(5) =ER+COSTO+COSTO+((CSPSR+(COSRHO+CSXLMR+SINRHO+SNXLMR+COSDMU) 1 -SNPSR+SINRHO+SINDMU)/TODEN - TONUM+(COSRHO+SNXLMR -SINRHO+CSXL		ŀ	-11		1	- 1	1	ı
2.	:	2MR + COSDMU)/(TODEN+TODEN))	PDBCQL	İ	Ш		1	Į.	1	ı
3.		S(6) =ER+COSTD+COSTD+((CSPSR+COSRHO+SNXLMR+SINDMU +SNPSR+COSRHO 1+COSDMU)/TDDEN + TDNUM+COSRHO+CSXLMR+SINDMU/(TDDEN+TDDEN))	PDBCQL PDBCQL	L	Ш		İ		1	ŧ
5. 6. C		RETURN CROSS RANGE COMPUTATION	PDBCQL PDBCQL		1			j]	}
1.	570	COSDMU = COS(MU-YMXRF)	POBCOL	-	۲	ı	1	1		
8 9.	E 0.0	SINDMU = SIN(MU-YMXRF) CONTINUE	PDBCQL		ŧ	l		1	1	ı
9. 0.	280	STC = CSPSR +COSRHO+SINDAU - SNPSR+(SINRHO+CSXLMR -COSRHO+SNXLMR+	PDBCQL	ľ			i	ł	1	ŀ
1.	1	L COSDMU) TC = ASIN(STC)	PDBCQL PDBCQL	l		l	ł	1	1	1
		SCROSS=TC=ER	POBCOL	1			1	1	1	ı
3. 4.		IF(KK.LT.0) GB TO 610 F=TC+ER	PDBCQL PDBCQL	610-	٦ ا		1	ł	1	1
۰. د		PARTIALS OF CROSS RANGE	PDBCQL				1	1	1	1
. · ·	590	COSTC_COS(TC) S(5)= ER/COSTC+(-CSPSR+SINRHO+SINDMU - SNPSR+(COSRHO+CSXLMR+SINRHO	PDBCDL	l		ľ	ł	1	i	1
⊌.		+ SNXLMR* COSDAU))	POBCOL				1	1	1	ł
♥. 0.		S(6) = ER/COSTC+(CSPSR+COSRHO+COSDMU - SNPSR+COSRHO+SNXLMR+SINDMU) RETURN	PDBCOL PDBCOL	l			1	1	1	1
1 · C		TOTAL RANGE	PDBCOL	1			1	1	1	1
3.	600	COSDMU = COS(MU-YMXRF)	PDBCQL	1	\top	_		1.	İ .	1
4.	610	CONTINUE	PDBCOL		-	İ		1.	1 -	1
5. 6.		COSTHT = SINRHO+ SNXLMR + COSRHO+CSXLMR + COSDMU THT = ACOS(COSTHT)	POBCOL Pobcol					1	1	1
ī.		STOT ≈ ER+THT	PDBCQL			i		1	1	1
. .		IF(KK.LT.G) RETURN F= ER+THT	POBCOL POBCOL					1	1	
0.	620	SNTHT . SIN(THT)	PDBCQL							
1.	-	S(5)= -ER*(COSRHO*SNXLMR -SINRHO*CSXLMR*COSDMU) / SNTHT SINDMU= SINCMU-YMXRF)	PDBCQL PDBCQL					1	1	1
2. 3.		S(6) = COSRHO*CSXLMR*SINDMU/SNTHT*ER	PDBCQL					1	1	
4. c		GO TO 560 Dynamic Pressure	PDBCQL PDBCQL	560-				į	1 .	ŧ
6.	630	CONTINUE	PDBCQL	-					1	1
7 8 C		F= Q PARTIALS OF DYNAMIC PRESSURE	PDBCOL						1	i
8 € •.	640	S(1) = QR	POBCOL						1	1
o.		S(4) = QR Return	PDBCQL PDBCQL	ŀ					1	1
1 . C		HEATING RATE	POBCOL						į.	1
3	690	CONTINUE	POBCOL	-					_	1
4.		HTD = QMULT+17600.+SQRT(RO/RHOB)+(V/26000.)++3.15 F = HTD	PDBCQL PDBCQL	}						1
. ε		HEATING RATE PARTIALS	PDBCOL	ĺ						1
<i>i</i> .	700	S(1) = 3.15*HTD/V S(4) = HTD/2.4ROR/RO	PDBCQL PDBCQL	l						1
ه. ه. ر		RETURN	POBCQL							1
<u> </u>	75.0	REYNOLDS NUMBER	POBCOL	<u></u>						į
l. 2.		RE = V*RO/VNU F = RE	PDBCQL PDBCQL	Ĭ						
3. ε		PARTIALS OF REYNOLS NUMBER	POBCQL							
٠.		S(1) = RO/YNU S(4) = (V+ROR - RE+VNR)/YNU	PDBCQL PDBCQL							
, . •		RETURN	PDBCQL							
<u> </u>	000	FUEL WEIGHT (FIRST STAGE ONLY)	PDBCOL							
В 9.		WTFUEL = ZSAVE(7)+GR - W F= WTFUEL	PDBCQL PDBCQL							
		FUEL WT PARTIALS	PDBCQL							
U		S(T) = -GR	PDBCQL							
0. L 1. 2.		RETURN	PDBCOL							

ORIRAN YMBOL	MATH SYMBOL	CODE	DESCRIPTION		BLOCK	ORAG	LOC	SUBA (ODE	USAGE VAR
INCL	i		Orbital inclination	(RAD)	/ORBIT	/(7)	DUTPUT PDBCOL		AINCL AINCL
NOMLY	\$	A	True anomaly	(GAD)	/DRBIT	/(13)	OUTPUT	1	ANDMLY
POGEE	R,	0	Apogee radius	(FT)	/OR811	/(11)	OUTPUT	1	APOGEE APOGEE
RGP	۵,	*	Orbital argument of perigee	(RAD)	/ORBIT	/(8)	OUTPUT	1	ARGP ARGP
S C NO D	Ω	Ħ	Longitude of ascending node	(RAD)	/ORBIT	/(9)	OUTPUT POBÇEL	ī	ASCNOD ASCNOD
SYMP	θ	•	Outgoing asymptote	(RAD)	/ORBIT	/(16)	PDBCQL		ASYMP
APX	x	8	Asymptote parameter	т	/ORBIT	/(14)	POSCOL	0	CAPX
APY	Y	0	Asymptote purameter	(FT)	/ORBIT	/(15)	PDBCOL	0	CAPY
OSDMU	cos(µ-µ,)	n	See symbol		/ORBIT	/(163)	PDBCQL	Ħ	COSDMU
OS GAM	C 0 S 7	I	See symbol		/DYNA	/(4)	AL1 AL7 AL8 AL9 CONTRL NLDRY OUTPUT PDBCQL STATEF	1 1 1	COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM COSGAM
ÒSPSI	c o s≠	ī	See symbol		/DYNA	/(95)	AL4 AL7 AL8 AL9 CONTRL NLDRV PDBCGL STATEF	I	COSPSI COSPSI COSPSI COSPSI COSPSI COSPSI COSPSI COSPSI
OSRHO	c Q S P	I	See symbol		/DYNA	/(97)	AL4 AL7 AL8 AL9 CONTRL NLDRY OUTPUT PDBCQL STATEF	1 1 1	COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO COSRHO
PSII	cos(≠ _j)	Ħ	Cosine of inertial azimuth		/ORBIT	/(157)	PDBCQL	M	CPSII
SANO	cos(\$)	M	See symbol		/ORBIT	/(162)	POBCAL	M	CSANO
61	cos(7 ₁)	A	Cosine of inertial flight path angle		/ORBIT	/(155)	POBCOL	Ħ	CSEI
51	cos(i)	A	Cosine of inclination		/ORBIT	/(159)	PDBCQL	Ħ	CSI
PSR	c o s (\(\psi_F\)	1	Cosine of reference azimuth		/ORBIT	/(153)	CHECK POBCOL	0	CSPSR CSPSR
SXLMR	cos(ρ-ρ _r)	1	Cosine of reference latitude		/ORBIT			CHECK PDBCQL	-	CSXLMR CSXLMR
ANDS		0	Partial derivative of boundary condition		/ORBIT			PDBCQL	0	DANDS
NDH			Partial derivative of boundary condition		/OR811			PDBCQL		DANDH
NOM			Partial derivative of boundary condition		/ORBIT			PDBCQL		DANDA
NDMU			Partial derivative of boundary condition		/ORBIT			PDBCQL		DANDMU
ANDPS			Partial derivative of boundary condition		/ORBIT			PDBCQL		DANDPS
ANDRO			Partial derivative of boundary condition		/DRBIT			PDBCQL		DANDRO
ANDV Nov 72	2-6.01-47		Partial derivative of boundary condition		/ORBIT	/(103)	PDBCQL	0	DANDY
					-					
							-			

ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STORAGE BLOCK LOC	SUBROUTINE US
	3111002				
)APDG		0 Partial	derivative of boundary condition	/ORBIT /(90)	POSCOL O DAPE
) AP OH		O Partial	derivative of boundary condition	/ORBIT /(91)	POSCOL O DAPI
APBM		0 Partial	derivative of boundary condition	/ORBIT /(92)	PDBCQL 0 DAPI
DAPDAU		0 Partial	derivative of boundary condition	/ORBIT /(95)	POBCAL D DAPE
APOPS		0 Partial	derivative of boundary condition	/ORBIT /(93)	POSCOL O DAPE
APDRO			derivative of boundary condition		POBCOL O DAPI
APDV			derivative of boundary condition	/ORBIT /(89)	PDBCQL 0 DAPE
ASDE			derivative of boundary condition	/ORBIT /(125)	PDBCQL D DASI
ASDH		0 Partial	derivative of boundary condition	/ORBIT /(126)	POBCOL O DAS
ASDM		0 Partial	derivative of boundary condition	/ORBIT /(127)	POBCOL O DASI
ASDAU		0 Partial	derivative of boundary condition	/ORBIT /(130)	POBCOL O DASI
DASDPS		0 Partial	derivative of boundary condition	/ORBIT /(128)	PDBCOL D DASI
ASORO		0 Partial	derivative of boundary condition	/ORBIT /(129)	POBCOL O DASI
ASDV			derivative of boundary condition	/ORBIT /(124)	PDBCQL 0 DASI
BEDS			derivative of boundary condition		POBCOL D DBEI
BEDH			derivative of boundary condition	/ORBIT /(70)	POBCOL O DBEI
BEDM			derivative of boundary condition	/ORBIT /(71)	POBCOL O DBEI
BEDMU			derivative of boundary condition	/ORBIT /(74)	POSCOL O DBE
BEOPS			derivative of boundary condition	/ORBIT /(72)	POBCAL O DBE
BEDRO			derivative of boundary condition	/ORBIT /(73)	POBCOL O DBEI
BEDV			derivative of boundary condition		POSCAL O DEEL
CXDE		-	derivative of boundary condition		PDBCQL O DCX
CXDH			derivative of boundary condition		POSCOL O DCXI
CXDM			derivative of boundary condition		POBCOL O DCX
CXDMU			derivative of boundary condition		POSCOL O DEXI
CXDPS			derivative of boundary condition		POBCOL O DCX
CXDRO			derivative of boundary condition	/ORBIT /(115)	POBCAL O DCX
CXBV			derivative of boundary condition	/ORBIT /(110)	POBCOL O DCX
CYDG			derivative of boundary condition		POBCOL O DCY
CYDH			derivative of boundary condition	/ORBIT /(119)	POBCOL O DEY
CYDM			derivative of boundary condition		POBCOL O OCY
CYDAN			derivative of boundary condition	/ORBIT /(123)	PDBCQL 0 DCY
CYDPS			derivative of boundary condition	/ORB1T /(121)	POBCAL D DCVI
CYDRO			derivative of boundary condition	/ORBIT /(122)	POBCOL D DCY
CYDV		O Partial	derivative of boundary condition	/ORBIT /(117)	POBCOL O DCY
ECDS			derivative of boundary condition	/ORBIT /(55)	POBCOL M DECI
ECDH			derivative of boundary condition		POBCOL M DECI
ECDM			derivative of boundary condition		PDBCQL O DEC
ECOMU			derivative of boundary condition		PDBCQL 0 DEC
ECOPS			derivative of boundary condition		PDSCOL M DECI
EÇORO			derivative of boundary condition		POBCOL M DECI
ECDV			derivative of boundary condition		POBCOL M DECI
END6			derivative of boundary condition		POBCOL O DEN
ENDH			derivative of boundary condition		POBCOL O DENI
ENDM		-	derivative of boundary condition		POBCOL O DEN
ENDAU			derivative of boundary condition		POBCOL O DEN
ENDPS			derivative of boundary condition		POBCOL O DEN
DENDRO			derivative of boundary condition		POBCAL O DEN

OGIDG OGIOH OGIDMU OGIDPS OGIDRO OGIDPO OGIDPO OGIDPO OGIDPO	SYMBOL	M Part O Part O Part	DESCRIPTION al derivative of boundary condition al derivative of boundary condition al derivative of boundary condition	ORBIT /(/ORBIT /(/ORBIT /(POBCOL M	DGIDG
OGIOH DGIDM DGIDMU DGIDPS DGIDRO DGIDV OIDG		# Part O Part O Part	al derivative of boundary condition al derivative of boundary condition	/ORBIT /(90106
OGIOH DGIDM DGIDMU DGIDPS DGIDRO DGIDV OIDG		# Part O Part O Part	al derivative of boundary condition al derivative of boundary condition	/ORBIT /(06106
OGIDM DGIDMU DGIDPS DGIDRO DGIDV OIDG		O Part D Part	al derivative of boundary condition		28)		
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D61 DRO D61 DV D1 D6		M Part	al derivative of boundary condition	/ORBIT /(32)	PDBCOL 0	DEIDWA
01De 061DA			al derivative of boundary condition	/ORBIT /(30)	PDBCQL M	DEIDPS
9010		M Part	al derivative of boundary condition	/ORBIT /(31)	POBCAL M	DEIDRO
		M Part	ai derivative of boundary condition	/ORBIT /(56)	POBCOL M	DEIDA
DIDH			al derivative of boundary condition	/ORBIT /(POBCOL M	0106
			al derivative of boundary condition	/ORBIT /(63)	PDBCQL #	BIDH
01DM		0 Part	al derivative of boundary condition	/ORBIT /(64)	POSCOL O	DIDM
DIDMU		0 Part	al derivative of boundary condition	/ORBIT /(67)	POBCOL 0	DIDMU
DIOPS		M Part	al derivative of boundary condition	/ORBIT /(65)	PDBCQL #	DIDPS
DIDRO		M Part	al derivative of boundary condition	/ORBIT /(66)	POBCAL M	DIORO
DIDA		M Part	al derivative of boundary condition	/ORBIT /(61)	POBCOL M	DIDA
DMIDG		0 Part	al derivative of boundary condition	/ORBIT /(43)	PDBCOL D	DMIDG
DMIDH		0 Part	al derivative of boundary condition	/ORBIT /(42)	POBCOL 0	DMIDH
DMIDM		0 Part	al derivative of boundary condition	/ORBIT /(43)	PDBCQL 0	DMIDM
UMBIMB		0 Pert	al derivative of boundary condition	/ORBIT /(46)	POBCAL 0	BMIDMU
DMIDPS		0 Part	al derivative of boundary condition	/ORBIT /(44)	PDBCQL 0	DMIDPS
DMIBRO		0 Pert	al derivative of boundary condition	/ORBIT /(45)	PDBCQL 0	DMIDRO
D M1 D V		0 Part	al derivative of boundary condition	/ORBIT /(40)	PDBCQL 0	DMIDV
DM0D6		0 Part	al derivative of boundary condition	/ORBIT /(139)	POBCOL O	DMODS
DMODH		0 Part	al derivative of boundary condition	/ORBIT /(140)	POBCOL O	DMODH
DMOOM		0 Part	al derivative of boundary condition	/QRBIT /(141)	POBCOL 0	DRODA
DMOOMU		0 Part	al derivative of boundary condition	/ORBIT /(144)	POBCOL O	DRODAL
DMODPS		0 Part	al derivative of boundary condition	/ORBIT /(142)	PDBCQL 0	DMODPS
DMODRO		0 Part	al derivative of boundary condition	/ORBIT /(143)	PDBCQL D	DRODRO
DMODV		0 Part	al derivative of boundary condition	/ORBIT /(138)	PDBCQL 0	DMODY
DNODG		0 Part	al derivative of boundary condition	/ORBIT /(76)	PDBCQL 0	DNODG
DNODH		0 Part	al derivative of boundary condition	/ORBIT /(77)	POBCOL 0	DNODH
DNODM		0 Part	al derivative of boundary condition	/ORBIT /(78)	PBBCGL 0	DNODM
DNODMU		0 Part	al derivative of boundary condition	/ORBIT /(81)	POBCAL 0	DNDDM
DNODPS		0 Part	al derivative of boundary condition	/ORBIT /(79)	PDBCQL 0	DNODPS
DNODRO		0 Part	al derivative of boundary condition	/ORBIT /(80)	POBCOL O	DNDDRO
DNODV		0 Part	ai derivative of boundary condition	/ORBIT /(75)	POBCUL O	DNODY
DPD6		M Part	al derivative of boundary condition	/ORBIT /(48)	PDBCOL M	DPDS
DPDH		M Part	al derivative of boundary condition	/ORBIT /(49)	PDBCOL #	DPDH
DPDM		0 Part	mi derivative of boundary condition	/ORBIT /(50)	PDBCQL D	DPDM
DPDMU		0 Part	al derivative of boundary condition	/ORBIT /(53)	PDBCQL 0	DPDMU
DPDPS		M Part	al derivative of boundary condition	/ORBIT /(51)	POBCOL M	DPDPS
DPDRO			al derivative of boundary condition	/ORBIT /(52)	PDBCQL M	DPDRO
DPDV			al derivative of boundary condition	/ORBIT /(47)	POBCOL M	DPDV
DPEDG			al derivative of boundary condition	/ORBIT /(97)	POBCOL O	DPEDG
DPEDH			al derivative of boundary condition	/ORBIT /(98)	POBCOL O	DPEDH
DPEDM			al derivative of boundary condition	/QRBIT /(POBCOL O	DPEDM
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DPEDPS			al derivative of boundary condition	/ORBIT /(POBCOL O	DPEDPS
DPEDRO			al derivative of boundary condition	/ORBIT /(PDBCOL D	DPEDAG
OPEDV			al derivative of boundary condition	/ORBIT /(POBCOL O	DPEDV

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SYMBOL	MATH Symbol	CODE	DESCRIPTION	BLOCK	LOC	SUBROUTINE SUBR CODE	
09106			Partial derivative of boundary condition	/ORBIT /(34)	POBCOL M	02106
OPION		M	Partial derivative of boundary condition	/ORBIT /C	351	POSCOL M	DPION
DPIDM		0	Partial derivative of boundary condition	/ORBIT /(36)	PDBCQL 0	OPION
DPIDMU		0	Partial derivative of boundary condition	/0R81T /(39)	POBCAL O	OPIOMU
OPIDPS		Ħ	Partial derivative of boundary condition	/ORBIT /(37)	POBCOL M	OPIDPS
OPIORO		M	Partial derivative of boundary condition	/ORBIT /C	38)	POBCOL M	OP 1 OR 0
OPIOV		m	Partial derivative of boundary condition	/ORBIT /(33)	POSCOL M	OPIDV
OSMOG		ĸ	Partial derivative of boundary condition	/GR81T /(63)	POBCOL M	05406
DSMDH		M	Partial derivative of boundary condition	/ORBIT /(84)	PDBCOL M	DSMON
OSMDM		G	Partial derivative of boundary condition	/ORBIT /(85)	POSCOL O	OSMOM
DSMDMU		0	Partial derivative of boundary condition	/ORBIT /(88)	POBCOL O	DSMDMU
DSMOPS		Ħ	Partial derivative of boundary condition	/ORBIT /(86)	POBCEL M	05m0P5
DSMORO		M	Partial derivative of boundary condition	/DR81T /(87)	PDBCQL M	DSMDRO
OSMBV		M	Partial derivative of boundary condition	/ORBIT /(POSCOL M	BSADV
DAIDE		M	Partial derivative of boundary condition	/ORBIT /(DAIDE
DAIDH		M	Partial derivative of boundary condition	/ORBIT /(PBBCGL #	DAIBH
DAIDW		0	Partial derivative of boundary condition	/08BIT /(PDBCQL 0	DAIDW
UMCIVO		0	Partial derivative of boundary condition	/ORBIT /(POBCOL O	DAIDUR
DVIDPS		R	Partial derivative of boundary condition	/ORBIT /(PDBCQL M	DAIDEZ
OVIDRO		Ħ	Partial derivative of boundary condition	/ORBIT /(POBCOL M	GVIDRO
DAIDA		n	Partial derivative of boundary condition	/ORBIT /(19)	POBCOL M Pobcol I	DAI DA
ECC	e	M	Orbital eccentricity	/ORBIT /(6)		ECC ECC
ENERGY	E	0	Energy	/ORBIT /(17)	OUTPUT I Pobcal o	ENERGY ENERGY
EA	ER	1	Earth radius. (FT)	/GLOBAL/(2)	ENVPRO I POBCOL I OLTOSZ I STATEF I	ER ER ER ER
GAMI	7 1	0	Inertial flight path angles (RAD)	/ORBIT /(2)	OUTPUT I PDBCOL D	GAMI GAMI
6 m	GM	1	Product of Newton's universal gravitational constant and the mass of the earth. (FT $^3/\text{SEC}^2$)	/6L08AL/(67)	OUTPUT I POBCOL I STATEF I	6# 6# 6#
GR	9,	1	Gravitational acceleration at surface of the earth. $ (\text{FT/SEC}^2) $	/GLOBAL/(1)	ALS I APPLY I BRANPT I COSTAB I COSTAI I INTRPT I OUTPUT I PDBCQL I QLTOSZ I SALVE I STATEF I TM3 I	SR SR GR GR GR GR GR GR GR GR
HMNTM	н	R	Momentum	/ORBIT /(18)	OUTPUT 1	HANTA HANTA
1PFL61		Ī	IPFLG1≠0 supresses print-out of velocity losses and inertial Euler angles.	/GLOBAL/(69)	OUTPUT I POBCQL I QLTOSZ O SALVE I	IPFL61 IPFL61 IPFL61 IPFL61
MU	μ	1	Relative longitude (RAD)	/0 /(96)	OUTPUT I POBCOL I WRAPUP I	MU MU MU

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ORIRAN	MATH Symbol	C001	DESCRIPTIO	N	SIORA BLOCK	GE LOC	SUBACUTIN SUBA COD	E USAGE
SYMBOL	314000		5200.11.110		- BEUGA		3084 600	E WAN
OME GA	W	1	Earth rotation rate	(RAD/SEC)	/DYNA /(5)	AL4 I AL7 I CONTRL I PDBCQL I TRAJIN M	OMEGA DMEGA DMEGA DMEGA OMEGA
OMGZ	u	I	Earth rotation rate	(RAD/SEC)	/6L0B4L/(3)	POBCOL I Trajim I	OMSZ OMSZ
ORBPRM	v _I	1	Inertial velocity	(FT/SEC)	/3R81T /(1)	OUTPUT I POSCOL I POSCOL M	VI ORBPR# VI
P '	Pr	Ħ	Semi-latus rectum	(FT)	/0861T /C	5)	OUTPUT 1 PDSCOL M	P P
PERGEE	R	8	Perigee radius	(FT)	/0881T /(12)	OUTPUT I	PERGEE PERGEE
PPO		I	Partial derivative of boundary com	lition	/ORBIT /C	193	POBCOL M	BVIOV PPO
PSII	≠ 1	n	Inertial azimuth	(RAD)	/ORBIT /C	3)	OUTPUT I	P511 P511
0	9	1	Dynamic pressure	(LBS/FT ²)	/DYNA /(27)	ENVPRO I OUTPUT I POBCOL I STATEF M UT I	0 0 0
QMULT	=0 OR 1	1	Heating flag multiplier		/ARCDAT/C	40)	NLORY I	OMULT OMULT
OR	A6/be	1	See symbol		/DYNA /(29)	PDBCOL I STATEF # UT I	OR OR OR
٥v	84/9 V	I	See symbol		/DYNA /(28)	POBCQL I STATEF M UT I	54 64 64
R	R	ī	Radial distance from earth center (to vehicle (FT)	/DY4A /(7)	AL4 I AL7 I AL8 I AL9 I CONTRL I ENVPRO I NLDRV I POBCOL I OLTOSZ I STATEF M	R R R R R R R R R
RHOB	P .	I	Atmosphere base density for heating	calculation (LB/FT++3)	/ARCDAT/(39)	WLDRY I POBCQL I	RHOB
RO	ρ _a	1	Atwaspheric density	(SLGS/FT ³)	/DYMA /(15)	ALT I ALB I AL9 I NLDRY I OUTPUT I POBCQL I STATEF I	RO RO RO RO RO RO
ROR	a ρ •/aR	1	See symbol		/DYNA /(19)	AL7 I AL8 I AL9 I NLDRV I POBCOL I STATEF I	ROR ROR ROR ROR ROR
SCROSS	s _c	0	Cross range	(FT)	/ORBIT /(149)	OUTPUT I PDBCQL O	SCROSS SCROSS
500 MM	S _D	0	Down range	(FT)	/0R81T /(148)	OUTPUT I	SDOWN SDOWN
SINDMU	sin(μ-μ _r)	•	See symbol		/0881T /(164)	POSCOL M	SINDMU

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION		STO BLOCK	ARC	FE TOC	SUBRO SUBR	CODE	USAGE
		1	Con cushal		/DYNA	/(AL3	,	5 X N C A C
SINGAM	sin?	•	See symbol		, D1 44	,	3,	AL4 AL7 AL8 AL9 CONTRI NLDRY PDBC9 STATE	l L I	Singap Singap Singap Singap Singap Singap Singap Singap
SINPS1	s i n¥	J	See symbol		/DYNA	/(94)	AL4 AL7 AL8 AL9 CONTRI NLDRY PDBCGI STATES	I L I	\$1 MP\$1 \$1 MP\$1 \$1 MP\$1 \$1 MP\$1 \$1 MP\$1 \$1 MP\$1 \$1 MP\$1
SIMRHO	sinp	1	See symbol		/BY##	/(96)	AL4 AL7 AL8 AL9 CONTRI NLDRY OUTPU PDBCQ STATE	1 T I L I	SINAHO SINAHO SINAHO SINAHO SINAHO SINAHO SINAHO SINAHO SINAHO
LAM IM2	a ₅	Ħ	Semi-major axis	(FT)	/ORBIT	/(10)	POBCO		SMIMAJ SMIMAJ
SNGI	sin(₂ ,)	Ħ	Sine of inertial flight path angle		/ORBIT	/(154)	PDSCO	LM	SMGI
SNGNU	sin(ν)	Ħ	See symbol		/ORBIT	/(161)	POBCO	LM	SMGMU
SNI	sin(1)	Ħ	Sine of inclination		/ORBIT			POBCO	_	SMI
SNPSR	sin(♥ _r)	1	Sine of reference azimuth		/ORBIT	/(152)	POBCO		SNPSR SNPSR
SNXL#R	$sin(\rho^-\rho_F)$	1	Sine of reference intitude		/ORBIT	/(146)	CHECK		SNXLMR SNXLMR
59511	sin(Ψ _t)	Ħ	Sin of inertial azimuth		/ORBIT	/(156)	POBCQ	LA	SPSII
5101	5,	0	Total range	(FT)	/ORBIT	/(158)	OUTPU PDBCQ QLTOS	LO	STOT STOT STOT
10	ø _c	M	Cross range engle	(RAD)	/ORBIT	/(151)	PDBCB	LM	TC
TD	₽ 0	M	Down range angle	(RAD)	/OR811	/(150)	PDBCO	LA	TD
THT	9 _T	Ħ	Total range angle	(FT)	/ORBIT	/(165)	PDBCO	L #	THT
TIME		I	Trajectory time	(SEC)	/DY4A	/(2)	ENVPRI DUTPU PDBCQ: STATE WRAPU	T I L I F A	TIME TIME TIME TIME TIME



FORTRAN Symbol	MATH Symbol	CODI	DESCRIPTIO	N	BLOCK	DRAG	LOC	SUBROUTII SUBR COI	E VAR
•	V	ī	Relative velocity.	(FT/SEC)	/0	/(91)	ALI I AL4 I AL7 I AL8 I AL9 I BCOND I BNDANPT M CONTRL I ENVPRE I FEICH O INTERP M INTERP M NLORV O NLORV I PDBCQL I STATEF I WRAPUP I	A A A MOW MOW MOW MOW MOW A A A A A
AI	A ¹	Ħ	Inertial velocity	(FT/SEC)	/ORBIT	/(1)	OUTPUT I PDBCQL I PDBCQL M	VI ORBPRM VI
VMR	aμ_/aR	1	See symbol		/DYNA	/(215)	PDBCQL I	YNR
V#U	$\bar{\mu}_{\bullet}$	1	Atmospheric viscosity (dynamic)	(SLGS/FT/SEC)	/DYNA	/(214)	OUTPUT I	AMR
W	id	I	Welght	(LBS)	/DYNA	/(91)	ALS I EMVPRQ I OUTPUT I POBCQL I QLTOSZ I STATEF M TH3 I	# # #
XMUI	μ_{1}	Ħ	Inertial longitude	(RAD)	/ORBIT	/(4)	OUTPUT I	IUMI IUMX
YMXRF	Pr	1	Reference longitude	(RAD)	/ORBIT	/(145)	CHECK O	YMXRF YMXRF
ZSAVE		Ī	A twenty word array containing the initial arc of the state and costat point of the trajectory.		/D	/(151)	BCOND OBRANPT I COSTAB I COSTAI I INTRPT I PDBCQL I SALVE I	ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE

SUBRØUT I NE QL TØSZ

Purpose

QLTOSZ handles the interface between the QL trajectory module and the Phase I or II (SSSP) sizing modules.*

^{*}See documentation of subroutine TRTOSZ in Steepest Descent Module

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SUBROUTINE QLTOSZ
COMMON /*/ Y (820)
REAL MAGBY, MU, M, LV, LGAM, LPSI, LR, LRHD, LMU, LM, LTAU, NOM

**ELT ROOGN /*/ Y (820)
REAL MAGBY, MU, M, LV, LGAM, LPSI, LR, LRHD, LMU, LM, LTAU, NOM

**LIT /*

**LIT /*/ **AGBY, ERR, D9, D10, C(40), CSAYE(40), Y, GAM, PSI, **ALT, RROOGN /*

**LIT /**ALT, MAGBY, ERR, D9, D10, C(40), CSAYE(40), Y, GAM, PSI, **ALT, RROOGN /*

**LIT /**ALT, MAGBY, LERR, D9, D10, C(40), CSAYE(40), Y, GAM, PSI, **ALT, RROOGN /*

**LIT /**ALT, MAGBY, LERR, D9, D10, C(40), CSAYE(40), DELT(20)

**DIMENSION WORLD /**AVE(20), OT(20), OT(20), MPOINT(20), DELT(20)

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OSMORO, OSMORU, DAPDV, DAPDG, DAPDH, DF
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     117.
                                                                                                                   CONTINUE

SO(17, 1) = Y(1)

SO(17, 2) = Y(2)*AAD

SO(17, 3) = Y(4)*ER

SO(17, 3) = Y(4)*ER

SO(17, 4) = Y(3)*RAD

SO(18, 1)*ZY(6)*RAD

MORBI = 10*(MORBI - 1) + 7

SY(7) = GR*Y(MORBI)

IF(MFARC .EQ. MARC) GO TO 7

INTB = 2

NS8 = MBRAN

MSAB = NFARC - MSB

GO TO 8
                                                                                                       5 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             JUL21
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JUL21
 132
                                                                                                   7 INTB = 0
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     133.
                                                                                                     8 CONTINUE
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                                                                                   IFINTB.NE.2) RETURN

SV(21)=1.

CALL QLNVPI
RETURN

II INTERMEDIATE ARC DATA

ENTRY QLAEND
IM1 = IARC

IF(JTYP.LE.0) GO TO 30
II-A PHASE I SIZING DATA
10 CONTINUE
II-B TEST FOR KEY ARCS
BOOSTER THRUST TERMINATION ARC

IF (IFIX(SQ(1,1)).EQ.IM1) GO TO 100

CPTIMAL STAGE TIME

20 IF( IFIX(SQ(1,2)).EQ.IM1) GO TO 110
                                                                                                                         IF(INTB.NE.2) RETURN
   134.
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 148.
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149.	C OPTIMAL PITCHOVER TIME	JUL21	Ι.					
150	30 IF (IFIX(SQ(13,3)).EQ.IM1) 60 TO 120	JUL21	120-	<u> </u>	- 1		ŀ	
151.	C TEST FOR BRANCHING AND INJECTION	JUL21		1 1	ľ		500-	_
152. 153	IF(1NTB.EQ.2.AND.NSB+NSAB.GE.IF1X(SQ(1,3)).AND.IARC.EQ.NSB+NSAB) # 60 TO 500	JUL21 JUL21	1	1 1			- 000]
1>4.	C TEST FOR BRANCHING AND ENTRY TERMINUS IF(INTB.EQ.2.AND.NSB+NSAB.LT.IFIX(SQ(1,3)).AND.1ARC.EQ.NSB+NSAB)	JUL21 JUL21	1	1 1	- 1		l	600-
1>> .	◆60 TO 600	JUL21	1	1 1	٠ ا			
1>7.	RETURN C BOOSTER CHARACTERISTIC VELOCITY	JUL21 JUL21	l	1 1	- 1			l
159.	100 VSTG = AP(17)	JUL21		1		. 1	Ì	1
160.	IF(JTYP.EQ.1) GO TO 20 C III-A PHASE 11 AT STAGING POINT	JUL21 JUL21		I	- 1	20-		ļ
161.	QP(9) =AP(9)	JUL21	l	1	- 1			
163.	SW(10)=STOT/ER SW(20)=AP(1)	JUL21 JUL21		1	- 1			
164 . 165 .	SV(7)=W	JUL21	1	1	- 1	1		ĺ
166.	SV(8) =AP(3) SV(9) =AP(2)	JUL21 JUL21	l		t			
140.	5v(10)=AP(4) 5v(12)=AP(32)	JUL21 Jul21	l	1	ł		1	ł
160.	5v(17)=AP(5)	JUL21	l	1				
1/1.	Sv(18)=AP(7) Sv(19)=AP(6)	JUL21 JUL21	l		- 1			ŀ
1/2.	Sv(21)= 0.	JUL21	ĺ	1	- 1			
1/4.	SV(22)= R SV(23)= AP(30)	JUL21 JUL21			- 1	4		١.
1/0.	SV(24)= AP(29) SV(25)= 0.	JUL21 JUL21	l	1	- 1	- 1		
1//.	5v(2k)= 90,- AP(92)	JUL21	l	-	·	- 1		
1/4.	SQ(12,1) = AP(77)/FTNM/ER SQ(36,1)= AP(55)	JUL21 JUL21		1		ı		
100.	\$Q(36,2)= AP(56) \$Q(37,1)= AP(1)	JUL21		ł	- 1		ı	
142.	GD TO 20	JUL21 JUL21	1	ł	Į:	لده		
184. 185.	110 5Q(18,2) = AP(8) GO TO 150	JUL21 JUL21		150-				
186	120 SQ(18,3) = AP(8)	JUL21		1.,,		Į		
187.	150 RETURN	JUL21	 -			l		
188. 189.	300 CONTINUE Return	JUL21 JUL21	1			•		
190.	ENTRY IRJNDO	JUL21	.			ļ		
192.	IF(JTYP-1)150, 310,400	JUL21	310-	J 400-	156-	1		
193.	310 IDVEL= AP(17) DVO = AP(17) -WSTG	JUL21 JUL21	i			l		
194.	WFO = AP(9) GO TO 150	JUL21	ĺ		150-	j		
196.	400 CONTINUE	JUL21	-		1			
197.	IF(INTB.NE.2) GD TO 500	JUL21	500-					600-
198.	IF(IFIX(SQ(1,3))-NSB-NSAB)600,500,500 C PHASE II INJECTION PT. DATA	JUL21 JUL21	500					000
200.	500 PZ(1) = AP(7)	JUL21	—					'
201. 202.	PZ(2) = AP(6) PZ(3) = AP(2)	JUL21	l					
203.	PZ(4) = Y(3)*RAD - AP(5) PZ(5) = AP(20)	JULZI JULZI	l					
204. 20>.	SV(7) = SO(3,5)	JUL21						j
200.	SV(3) = AP(17) SV(4) = AP(9)	JUL21 JUL21	i					
201. 200.	Sv(5) = Sv(7) -Sv(4)	JUL21						
204.	SQ(3,1)= AP(67) SQ(3,2)= AP(68)	JUL21 JUL21	l					
210. 211.	\$0(3/3)= AP(69) \$0(3/3)= AP(69) \$0(14,4)= AP(10)	JUL21 JUL21						
212.	50(14.5)= AP(Z)	JUL21	Ī					
213. 214.	SQ(15.3)= AP(11)	JUL21 JUL21						
21». 21».	50(15,4)= AP(64) 50(36,3)= AP(55)	JUL21						1
211.	59(36,4)= AP(56) 59(36,5)= AP(57)	JUL21						
210. 214.	C ORBITER BURN TIME	JUL21						Ì
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220. 10RB1 = SP(1,3) 221. SP(37, 2) = AP(1) - SP(37, 1) 222 RETURN 223. C PHASE II ENTRY END POINT) - (RRUISE RANGE)	JUL 21 JUL 21 JUL 21 JUL 21	
224. 600 SW(15) = AP(20) 225. RETURN 226. END		JUL21 JUL21 JUL21	· · · · · · · · · · · · · · · · · · ·
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ORTRAN Symbol	MAIH Symbol	CODE DESCR	IPTION	BLOCK	G€ LOC	SUBROUTIN Suba coo	
	·····		 		 -		
DAO		O Orbiter ideal velocity (f	98)	/\$121NG/C	307)	QLTOSZ O	DVO
ER	ER	I Earth radius.	(FT)	/GLDBAL/(2)	ENVPRO 1 POBCOL I OLTOSZ I STATEF I	ER ER ER
GR	9 r	1 Gravitational acceleration	n at surface of the earth. (FT/SEC ²)	/GLOBAL/(1)	ALS I APPLY I BRANPT I COSTAI I INTRPT I OUTPUT I POBCQŁ I QLTOSZ I SALVE I THA	GR GR GR GR GR GR GR GR GR
IARC	I	l Subarc Number.		/CNTRL /(24)	ARCIM I BCOND M BRANPT I CHECKE M COSTABI I FORCES I INARPT I MARC M MARCH MARCH I GLTOSZ I SALVE M MARCH MARCH I GLTOSZ I SALVE M MARCH M	I ARC I I ARC I I I I I I I I I I I I I I I I I I I
IDVEL		O Total ideal velocity requi	red to orbit (fps)	/\$121NG/(297)	ALTOSZ O	IDVEL
IPFLG1		O IPFLGI#O supresses print-c inertial Euler angles.	out of velocity losses and	/GLOBAL/(69)	OUTPUT I POBCOL I OLTOSZ O SALVE I	IPFL61 IPFL61 IPFL61 IPFL61
1PFLG2		O IPFL62#O supresses print-c	out of orbital parameters.	/SLOBAL/(70)	OLTOSZ O	IPFLG2
1PFLG3		O IPFLG3#O supresses print-c	out of impact data.	/GLOBAL/(71)	OUTPUT I OLTOSZ O	IPFL63
JTYP		I Sizing. Fing.	•	/SIZING/(313)	GLTOSZ I Wrapup I	9YTL 9YTL
MARC	N ₃	I Number of subarcs in the g	rables.	/6L08AL/(18)	BCOND I BNDRY I CHECK I ENDPT I FETCH I INARC I MAGIC I MAGIC I QLTOSZ I WRAPUP I	MARC NARC NARC NARC NARC NARC NARC NARC N
NBRAN	N _I	I Number of the last subarc problem. If the problem i them MBRAN = 0.		/GLOBAL/(19)	BNDRY I BRANPT I COSTAB I ENVPRQ I INTRPT I MAGIC I QLTOSZ I SALVE I	NBRAN NBRAN NBRAN NBRAN NBRAN NBRAN NBRAN NBRAN

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	STOR BLOCK	LOC LOC	SUBROUTING SUBR COO	
NFARC	N ₂	1	Number of the last subarc on the first branch. If the problem is not a branch problem, then NFARC = NARC.	/GLD8AL/	(20)	BCOND I BNORY I BRANPT I COSTAB I ENVPRQ I INTRPT I MAGIC I QLTDSZ I SALVE I	NF ARC NF ARC NF ARC NF ARC NF ARC NF ARC NF ARC
ORBI		1	Orbiter ignition arc	/5121NG/	(316)	OLTOSZ I	1890
Я	R	t	Radial distance from earth center to vehicle (FT)	/DYMA /	(1)	AL4 I AL7 I AL8 I AL9 I CONTRL I ENVPRQ I MLDRV I POBCQL I STATEF M	R R R R R R R R R R R R R R R R R R R
50		M	A synthesis data array (37,5) that contains the flyback data and some injection quantities	/S12146/	(74)	ENVPRO M OLTOSZ M	SO SD
STOT	S _T	1	Total range (FT)	/0881T /	(158)	OUTPUT I POBCAL O OLTOSZ I	STOT STOT STOT
SV		Ħ	A synthesis array (28) containing staging parameters and misc flags	/SIZING/	(46)	EMVPRO M BLTOSZ M	SV
SW		0	A synthesis array (20) containing counters and sizing options	/S121NG/	(26)	OLTO52 0	SM
VSTG		M	Booster staging velocity (fps)	/S121NG/	(311)	OLTOSZ M	VSTE
•	W	I	Weight (LBS)	/DYNA /	(91)	ALS I ENVPRO I OUTPUT I POBCOL I OLTOSZ I STATEF M TH3 I	# # # # # # # # # # # # # # # # # # #
WF0		0	Orbiter burnout meight (16)	/SIZING/	(296)	QLTOSZ O	WF D
Y		I	An 820 word array containing the particular and hamogeneous solutions being integrated. The first 18 words comprise the particular solution. Each block of 18 words thereafter comprises amindependent homogeneous solution.	/4 /	(1)	SROPE DIMARC MADAMS MALTOSZ I RKUTT1 MASALVE MARAPUP I	4 4 4 4



SUBRØUTINE RKUTT1



Purpose

RKUTT1 carries out the standard fourth order Runge-Kutta integration of the particular and homogeneous solutions. It is used over the first three intervals of each subarc as a starting procedure for MADAMS.*

^{*}See Section 17.6 of Vol. I.

RKUTT1

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                                                             SUBROUTINE REUTTI(F)
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                                                                                                                      THIS ROUTINE CARRIES OUT THE STANDARD FOURTH ORDER RUNGE-KUTTA INTEGRATION OF THE PARTICULAR AND HOMO-GENEOUS SOLUTIONS. IT IS USED OVER THE FIRST THREE INTERVALS OF EACH SUBARC AS A STARTING PROCEDURE FOR MADAMS.
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             COMMON /D/
*X M X1(4), MAGBY, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI,
*ALT, RHO, MU, M, TAU, HT LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU,
*LHT, D109, D110, BV(40), ZSAVE(20), QT(20), NPOINT(20), DELT(20)
DIMENSION NOM(20)
EQUIVALENCE (NOM, V)
COMMON /STUFF/ FK(820, 4)
DIMENSION S(820), CC(4), FS(1), F(1)
EQUIVALENCE (FS, FK)
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                                                 T = H/2.

DATA CC/ 1., 2., 2., 1./

DO 1 1 = 1, NN

1 FS(1) = F(1)

X = X + T

CALL INTERP

DO 5 J = 2, 4

IF(J .NE. 4) GO TO 3

X = X + T

T = N

IF(KONVER) GO TO 3

NEWNOW = .TRUE.

L = KPT + 1

DO 2 I = 1, N

Z(1) = Z1(1, L)

3 L = J - I
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             46.
                                                                                                                                                                                                                                                                                                                                                   RKUTT1
                                                 2 Z(I) = Z(I, L)

3 L = J - I

D0 4 I = 1, NN

4 S(I) = Y(I) + T*FK(I, L)

5 CALL LINDRY(S, FK(I, J))

D0 7 J = 1, 4

T = CC(J)/6.*H

D0 7 I = 1, NN

7 Y(I) = Y(I) + T*FK(I, J)

RETURN

END
                                                                                                                                                                                                                                                                                                                                                  RKUTTI
RKUTTI
RKUTTI
 ld
             30.
51.
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53.
                                                                                                                                                                                                                                                                                                                                                 RKUTTI
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RKUTTI
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             38:
57.
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ORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOC	DRAGE K LOC	SUBROUTI SUBR CO	NE USAGI DE VAR
							
FK			20×4 array used to store the vectors k_1 , k_2 , and k_4 defined by Equations 17.6-2 thru -5 in I of this document.	/STUFF	/(11	MADAMS M RKUTT1 I RKUTT1 D	FK
FS			20x4 array used to store the vectors \mathbf{k}_1 , \mathbf{k}_2 , and \mathbf{k}_4 defined by Equations 17.6-2 thru -5 in I of this document.	/STUFF	/(1)	MADAMS M RKUTT1 I RKUTT1 O	FK
H	h] Inte	gration step size in quasitime.	/D	/(2)	AL4 I INARC M MADAMS I RKUTT1 I RKUTT2 I SALVE M WRAPUP M	H H H
KONVER			cal flag that indicates to the QL module that QL iteration is converged.	/CNTRL	/(28)	ALGCON I APPLY I ARCIN I COHOMO O GROPE O NLDRY I OUTPUT I RKUTTI I	KONVER KONVER KONVER KONVER KONVER KONVER KONVER
к р т 		poin	subarc point number. KPT = 1 on the first t of subarc, and KPT = NPTS on the last point he subarc.	/CNTRL	/(8)	BCOND OBNORY OFORCES IMAGIC ORKUTT1 ISALVE MURAPUP M	KPT KPT KPT KPT KPT KPT KPT
		I Tota = 18	I number of QL state and costate variables. N	/PC	/(2)	BNDRY I CHECK I INARC I LINDRY I NLDRY I NCMMAL I RKUTTI I BKUTTI I WAAPUP I	AS SM NS NS NA NA NA NA
IEWNOM		inte	gical flag that indicates to the Runge-Kutta gration whether or not the system Jacobian s to be reevaluated.	/CNTRL	/(15)	INTERP O LINDRY M RKUTT1 O SALVE O WRAPUP O	NEWNOM NEWNOM NEWNOM NEWNOM
in .			number of quantities currently being rically integrated.	/CNTRL	/(52)	BNDRY MINARC MADAMS I MAGIC MINARCIT MI	NN NN NN NN NN NN NN
			20 word array used to store the particular and geneous solutions.	18	/(1)	NORNAL M RKUTT1 M	\$ \$
ı	x	M The I	guasitima variable.	/0	/(1)	AL4 I BNDRY O ERROR I FETCH D FORCES I INARC M INTERP I MADAMS M RKUTT1 M RKUTT2 M STATEF I	X X X X X X X X X X

FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLO	CK CK	GE LOC	SUBROL SUBR	COD	USAGE VAR
٧		•	An 820 word array containing the particular and homogeneous solutions being integrated. The first 18 words comprise the particular solution. Each block of 18 words thereafter comprises an independent homogeneous solution.	/4	/(1)	GROPE INARC MADAMS OLTOSI RKUTTI SALVE WRAPUF	I I	* * * * * * * * * * * * * * * * * * *
1	Z	0	A 20 mord array used to store the total linear solution from the preceding QL iteration.	/1	/(1)	BNDRY BRAMPT ENOPT ENOPT INTERPT LINDRY NOMNAL OUTPUT RKUTTI RKUTTI RKUTTI SALVE WRAPUP		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
21		1	A 20x4 array containing the first four values of 2 in the present subarc.	/21	/(1)	INTERP RKUTT1 SALVE	1	ZI ZI ZI

SUBRØUT I NE RKUTT2



Purpose

RKUTT2 carries out the standard fourth order Runge-Kutta integration of the converged state/costate solution and the velocity losses.*

^{*}See Section 17.6 in Vol. I.

```
1.
2.
3.
4.
                                          SUBROUTINE REUTT2
                                                                                                                                                                                                                                       RKUTT2
                                                                                                                                                                                                                                       RKUTTZ
RKUTTZ
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Z
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                        20000
                                                                                 THIS ROUTINE CARRIES OUT THE STANDARD FOURTH-ORDER RUNGE-KUTTA INTEGRATION OF THE CONVERGED STATE/CO-STATE SOLUTION AND THE VELOCITY LOSSES
                                     1:
            Ð.
       JUL21
D
D
                                                                                                                                                                                                                                     CONTRACTOR REGULTT 122
                                 EQUIVALENCE (FS, FK)

DATA CC/ 1., 2., 2., 1./
T = H/2.
D0 1 I = 1, MM

1 FS(I) = ZO(I)
X = X + T
D9 5 J = 23 -4
IF(J .ME. 4) GD TD 3
X = X + T
T = M

3 L = J - 1
D0 4 I = 1, MM
4 S(I) = Z(I) + T*FK(I, L)
5 CALL NLORY(S, FK(I, J))
D0 7 J = 1, 4
T = CC(J)/6.*H
00 7 I = 1, MM
7 Z(I) = Z(I) + T*FK(I, J)
RETURN
END
                     C
 q
        30.
31.
32.
33.
                                                                                                                                                                                                                                      RKUTT2
RKUTT2
RKUTT2
         35.
36.
                                                                                                                                                                                                                                      RKUTT2
RKUTT2
RKUTT2
RKUTT2
        37.
38.
39.
40.
41.
42.
43.
RKUTT2
RKUTT2
                                                                                                                                                                                                                                      RKUTT2
RKUTT2
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FORTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	ST BLOCK	ORAGE LOC	S UBF S UB	R COI	NE USAG DE VAR
н	h	1	Integration step size in quasitime.	/D	/(;	I NAF I NAF MADA RKUT RKUT SALV WRAP	MS I T1 I T2 I	H H H H H DT
NN.		1	The number of quantities currently being numerically integrated.	/CNTRL	/(52	BNDR I NAR MADA MAGI NOMN RKUT RKUT SALV	C M MS I C M AL I T1 I T2 I	
x		M	The quasitime variable.	/D	/()	BAL4 BADR ERRO FETC FORC INAR INTE MADA RKUT SALT WRAP	R I I I I I I I I I I I I I I I I I I I	X X X X X X X X X X T
	z	•	A 20 mord array used to store the total linear solution from the preceding QL iteration.	/2	/(1	BNDR BRAN BRAN ENDP ENVP INTR INTR LIND NOTH REUT SALV WRAP	PT I I RO I I RO I I RO I I RO I I RO I I RO I I RO I I RO I I I I	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
20		1	A 20 word array containing the vector $f(X,Z,M)$ in Equation 17.1-7 in Vol.1 of this document.	/20	/(1) ENVP LIND OUTP RKUT WRAP	AV 1 UT 1 T2 1	20 20 20 20 20



SUBRØUT I NE SAL VE



Purpose

SALVE controls the subarc by subarc integration of the particular and homogeneous solutions. In addition it sets up all initial conditions on the state and costate.*

^{*}See Section 17 of Vol. I.

```
PROGRAM SALVE
                                                                                                                                                                                              THIS ROUTINE CONTROLS THE INTEGRATION OF THE PARTI-
CULAR AND HOMOGENEOUS SOLUTIONS OVER ALL THE SUBARCS SALVE
SALVE
SALVE
CULAR
MEDICAL SALVE
SALVE
CMTRL
            2.
3.
                                         0000
            4.
                                                                            CATRL
CATRL
CATRL
     10.
  CHTRL
JACOB
ARCDAT
                                                                                                                                                        LDAT/
,EJ
,IMODE
,HDMAX
,MAEC
,MISP
,XCGR
,MCND
,ARCND
                                                                                                                                                                                                                                                    XISP
JAER
GMDOT
MAED
MXCG
ZCGR
RHOB
                                                                                                                                                                                                                                                                                                                                     TMULT
JPRO
ALFMAX
MAEE
MZCG
XE
QMULT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ARCDAT
ARCDAT
ARCDAT
ARCDAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           , MWDB
, XT
, FRATE
                                                                                                                                                                                                                                                                                                                                                                                                                         , MWDA
, ZE
, REMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ARCDAT
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ARCDAT
ARCDAT
                                                                               ≠MT
≠MDB
                                                                            *DREF | MCND | RHOB | GMULT | REMAX | FRATE |
DIMENSION | ARCDA(40) |
EQUIVALENCE(SREF, ARCDA) |
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GLOBAL
                                                                           **REAL MARBO, MU, NI, LV, LGAM, LPSI, LR, LRHU, LMU, LM, LTHU, NUM
***COMMON /D/
**X, H, XI(4), MAGBV, ERR, D9, D10, C(40), CSAVE(40), V, GAM, PSI,
**ALT AHO, MU, M. TAU, HT, LV, LGAM, LPSI, LR, LRHO, LMU, LM, LTAU
**LHT, D109, D10, BV(40), ZSAVE(20), D1(20), NPOINT(20), DELT(20)
DIMENSION NOM(20)
**COMMON /BLOCK/ IIC(10, 20), IIC(10, 20), ITC(10, 20), JTAB(20),
**ITCT(10, 20), LTAB(20), NOKNOW, NOC(20), VALIC(10, 20),
**TCT(10, 20), LTAB(20), NOKNOW, NOC(20), VALIC(10, 20),
**COMMON /Z/ Z(50)
COMMON /Z/ Z(50)
COMMON /Z/ X(50)
COMMON /Y/ Y(820)
COMMON /PC/ F(820, 4)
COMMON /PC/
**PCI NORMAN (20), ADD(10), PC5, PC6, PC7, MAXBC, NAUX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             JUL21
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  44 .
45 .
46 .
47 .
                                                                                   PC1 N PC3 IDP PC5
DIMENSION BNOM(18), CNOM(18)
                                                                                                                                                                                            PC3
                                                                                                                                                                                                                                                                                                                                               ,PC6
                                                                                                                                                                                                                                                                                                                                                                                                    ,PC7
                                                                                                                                                                                                                                                                                                                                                                                                                                                            MAXBC . NAUX
                                                             L = 0

00 14 IARC = 1, NARC

00 90 I = 1, 400

90 JAKE(I) = 0
 40.
49.
50.
51.
                                                                                   READ IN THE DATA FOR THIS SUBARC.
                                                                                   CALL READMS(9, ARCDA, 42, IARC)
54.
55.
56.
57.
58.
                                     0000
                                                                                   STORE THE NUMBER OF POINTS FOR THIS SUBARC AND COMPUTE THE STEP-
                                                                                  NPTS = NPOINT(IARC)
H = 1. 0/FLOAT(NPTS - 1)
59.
60.
61.
                                     CCC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        COMPUTE NUMBER OF HOMOGENEOUS SOLUTIONS FOR THIS SUBARC.
                                                                                  MOM = NOC(IARC)
NN = N+(MOM + 1)
63.
64.
65.
66.
67.
68.
69.
70.
71.
72.
                                                                                  STORE THE FIRST FOUR POINTS OF THIS SUBARC.
                                                                              X = IARC - 1
NOPRNT = .FALSE.
DO 9 KPT = 1, 4
INDX(KPT) = KPT
XI(KPT) = X
CALL NOMNAL
DO 8 I = 1, M
```

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SALLYEE
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SALLYEE
SALLYEE
SALLYEE
                    4 76.
                                           8 21(1, KPT) = 2(1)
9 X = X + H
                          70.
                                               RESTORE THE FIRST POINT OF THE NOMINAL.
                         79.
80.
81.
82.
                                         DO 10 I = 1, M
10 Z(I) = ZI(I, 1)
X = IARC ~ 1
NEWNOM = .TRUE
                    d
                          83.
84.
85.
                                                                          SET UP THE INITIAL CONDITIONS OF THE PARTICULAR AND HOMOGENEOUS SOLUTIONS FOR THE START OF THIS
                         86.
87.
88.
89.
90.
                                                                          ARC
                                                                                                                                                                                SALVE
                                              DO 210 1 = 1, 9

IF(IIC(I, IARC) - 1) 201, 202, 204

CONTINUOUS STATE. IF THIS IS THE START OF THE 2ND
BRANCH, SET PARTICULAR SOL. TO VALUE AT END OF STEM.

OTHERWISE, LET PART. SOL. GO ACROSS CONTINUOUSLY.
                                                                                                                                                                                SALVE
SALVE
SALVE
SALVE
                                                                                                                                                                                               201-
                                                                                                                                                                                                       7202
                                                                                                                                                                                SALVE
                                       201 IF( | ARC . EQ. NFARC + 1) Y( | | = BNOM( | )
60 TO 210
                                                                                                                                                                                SALVE
                                                                                                                                                                                                                            210-
                          94
                                                                                                                                                                                SALVE
                                                                         NM, 18
KNOWN STATE. ZERO THIS STATE*S ROW IN ALL HOMOGEN-
EOUS SOLUTIONS UP TO THIS PT. AND SET THE PART. SOL.
TO THE DESIRED VALUE.
                          95.
96.
97.
98.
                                                                                                                                                                                SALVE
SALVE
                                        202 00 203 J = 1,
                                   CCC
                                                                                                                                                                                SALVE
                                                                                                                                                                                SALVE
SALVE
SALVE
                                       203 Y(J) = 0
Y(I) = VALIC(I, IARC)
GO TO 210
                        99.
                                                                                                                                                                                SALVE
                                                                                                                                                                                                                            210-
                                       204 IF(IIC(I, IARC) - 5) 205, 206, 208
UNKNOWN STATE. SET THE PART. SOL. FOR THIS STATE
EQUAL TO THE TOTAL SOL. FROM LAST ITER. AND INTRO-
                                                                                                                                                                                SALVE
SALVE
SALVE
SALVE
                        102.
                                                                                                                                                                                              705-
                                                                                                                                                                                                                 20A
                                                                                                                                                                                                        1206-
                        104.
                                                                          DUCE A NEW HOMO. SOL.
                                       205 Y(1) = I(1)

L = L + 18

IL = L + I

Y(IL) = 1

60 TO 210
                                                                                                                                                                                SALVE
                                                                                                                                                                                SALVE
SALVE
SALVE
SALVE
                        107.
                        100.
100.
110.
                                                                                                                                                                                                                            210-
                                                                          KNOWN DROP WEIGHT. IS THIS THE START OF 2ND BRANCH
                                                                                                                                                                                SALVE
                                       206 IF(1ARC .EQ. NFARC + 1) GO TO 207
NO. SUBTRACT OFF DROP WEIGHT FROM PART. SOL.
Y(1) = Y(1) - VALIC(1, 1ARC)
                                                                                                                                                                                              207-
                        112.
                                                                                                                                                                                SALVE
                                                                                                                                                                                SALVE
SALVE
SALVE
SALVE
SALVE
                        113.
                        114 .
                                               60 TO 210
                                                                                                                                                                                                                            210-
                        116.
                                                                          START OF 2ND BRANCH. SUBTRACT DROP MT. FROM PART. SOL. AT END OF STEM.
                        118.
                                       207 Y(1) = BNOM(1) - VALIC(1, IARC)
GD TO 210
                                                                                                                                                                                SALVE
                                                                                                                                                                                                                            210-
                                                                          SIZING DROP WT. IS THIS THE START OF 2ND BRANCH
                                                                                                                                                                                SALVE
                         20
                                      208 IF(|ARC .EQ. NFARC + 1) 60 TO 209

MO. SUBT. DROP MT. FROM PART. SOL.

MPRO = 6R*(ZSAVE(7) - M)

CALL MTDRP(MPRO, MDRP, DMDRP, 3)

Y(1) = Y(1) - MDRP/GR

GO TO 210
                                                                                                                                                                                              209
                        121.
                                                                                                                                                                                SALVE
                                   c
                                                                                                                                                                                SALVE
SALVE
SALVE
SALVE
                        122.
                       123.
124.
125.
                                                                                                                                                                                SALVE
                       127.
                                      209 IF(IIC(I, IARC) .LT. 7) 60 TO 2091

MT. DISTRIBUTION BETWEEN STEM AND BRANCHES. SUBT.

INITIAL MT. AT START OF 15T BRANCH FROM MT. AT END

OF STEM.

Y(7) = BNOM(7) - CNOM(7)

GO TO 210

SUBT. SIZING DROP MT. FROM THE MT. AT END OF STEM.
                                                                                                                                                                               SALVE
SALVE
SALVE
SALVE
SALVE
                                                                                                                                                                                              2091
                        128.
                                   č
                       129.
                       131.
132.
134.
                                                                                                                                                                                                          216
                                                                          SUBT. SIZING DROP WT. FROM THE WT. AT END OF STEM.
                                                                                                                                                                                SALVE
                                    2091 MPRO = GR*(ZSAVE(7) - BNOM(7))
CALL MTDRP(MPRO, MDRP, DMDRP, 3)
Y(1) = BNOM(7) - MDRP/GR
                                                                                                                                                                               SALVE
                        135.
                                                                                                                                                                               SALVE
SALVE
                        137.
                                       210 CONTINUE
                                                                                                                                                                               SALVE
                                              CONTINUE
DO 214 I = 1, 9
IF(IICT(I, IARC) -1) 214, 211, 213
KNOWN COSTATE. ZERO OUT THE APPROPRIATE ROW OF PART. AND MOMO. SOLS.
                                                                                                                                                                               SALVE
SALVE
SALVE
SALVE
                       138.
                                                                                                                                                                                              211-
                       140.
                    C 142:
                                      211 DO 212 J = I,
212 Y(J + 9) = 0'
60 TO 214
                                                                                                                                                                               SALVE
                                                                                                                                                                               SALVE
                                                                                                                                                                                                                  214
                                                                         IS THIS THE START OF THE 2ND
                                                                                                                                     RRAMEH
                                                                                                                                                                               SALVE
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213 IF(IARC .NE. NFARC + 1) GO TO 2131
YES. IS THIS COSTATE UNKNOWN.

IF(IICT(I, IARC) .EQ. 2) GO TO 2131
COSTATE DISTRIBUTION FROM STEM TO BRANCHES.SET PART.
SOL. FOR THIS COSTATE EQUAL TO DIFF.BETWEEN END OF
STEM AND START OF 1ST ARC
Y(I + 9) = BNOW(I + 9) - CNOW(I + 9)
GO TO 214
     146.
147. C
148.
149. C
                                                                                                                                                                                                 SALVE
SALVE
SALVE
SALVE
SALVE
SALVE
                                                                                                                                                                                                                    2131
                                                                                                                                                                                                                    2131
      151.
152.
                                                                                                                                                                                                  SALVE
     154.
                     2131 \ Y(1 + 9) = Z(1 + 9)
                                                                                                                                                                                                 SALVE
SALVE
SALVE
SALVE
SALVE
                                                                    UNKNOWN COSTATE. SET PART. SOL. TO VALUE OF TOTAL
SOL. FROM LAST ITER, AND INTRODUCE A NEW HOMO SOL.
                   ç
      155 .
       156
                                  L = L + 18
IL = L + I
Y(IL + 9) = 1
      157.
      160.
                                                                                                                                                                                                  SALVE
SALVE
SALVE
SALVE
                         214 CONTINUE
                                  CONTINUE

1F(NFARC .EQ. NARC .OR. 1ARC .EQ. NBRAN + 1) GO TO 216

DO 215 I = 1, 18

CNOM(I) = Y(I)
                                                                                                                                                                                                                    216-
      161.
      162.
     164.
165. C
166. C
167. C
                        21 CNOM(I) :
                                                                                                                                                                                                 SALVE
SALVE
SALVE
SALVE
SALVE
SALVE
SALVE
SALVE
SALVE
SALVE
                                   START THE INTEGRATION BY RUNGE-KUTTA.
                                 DO 12 KPT = 1, 4

IF(KPT .EQ. NPTS) NEWNOM = .TRUE.
CALL LINDRW(Y, F(1, KPT))
MRITECITAPB) (Y(IJ), IJ = 1, NN)
IF(KPT .NE. 1) GO TO 121
CALL OUTPUT
CALL WRITES(41, Y, NN, 2*IARC - 13*-
      168.
     169.
     1/1.
1/2.
1/3.
                                                                                                                                                                                                                    121-
                        121 IF(KPT .LT. 4) CALL RKUTTI(F(1, KPT))
FINISH INTEGRATION OVER THIS ARC BY ADAMS-MOULTON.
    175.
                                                                                                                                                                                                 SALVE
SALVE
SALVE
SALVE
                          12 CONTINUE
IF(KPT .EQ. NPTS)GO TO 131
      177.
                                                                                                                                                                                                                    131-
                           13 KPT = KPT + 1
NEWNOM = .TRUE.
CALL NOMNAL
CALL MADAMS
WRITE(ITAPB) (Y(IJ), IJ = 1, NN)
IF(KPT .LT. NPTS) GÖ TO 13
                                                                                                                                                                                                 SALVE
SALVE
SALVE
SALVE
SALVE
SALVE
     179.
180.
181.
     182.
183.
                                                                                                                                                                                                                    13-
                       1F(KP) ....

131 CALL OUTPUT

CALL WRITMS(41, Y, NN, 2*IARC)

IF(IARC .NE. NORAN) GO TO 14

THIS IS THE END OF THE STEM OF A BRANCH PROBLEM.

STORE THE PARTICULAR SOLUTION.
     185.
186.
                                                                                                                                                                                                 SALVE
SALVE
SALVE
SALVE
SALVE
SALVE
197.
188.
189.
190.
192.
193.
194.
                                                                                                                                                                                                                    14-
                          14 CONTINUE
IF(IPFLG1 .EQ. 0) CALL PRORPA
RETURN
                                                                                                                                                                                                 SALVE
JUL19B
SALVE
                                  END
                                                                                                                                                                                                 SALVE
     190.
```

FORTRAN Symbol	MATH Symbol	6001	DESCRIPTION	BLOC	ORAGE K LO	C	S UBROU S UBR	CODE	USAGI VAR
ARCDA	Sref	ī	Aerodynamic reference area (FT ²)	/ AR CDA	iτ/(1)	ARCIN BNDRY CHECK FETCH SALVE STATEF UT WRAPUP	I	SREF ARCDA ARCDA ARCDA SREF SREF ARCDA
F		1	An 820x4 array used to store the vectors k1, k2, k3, and k4 defined by Equations 17.6-7 thru -10 of Vol.1 of this document.	/F	/(1)	MADAMS Salve		F F
GR	9 _r	1	Gravitational acceleration at surface of the earth. (FT/SEC ²)	/GLOBA	L/(1)	AL5 APPLY BRANPT COSTAB COSTAI INTRPT OUTPUT POBCOL QLTOS SALVE STATEF TH3	I I I I I I	GR GR GR GR GR GR GR GR GR
н	h	• •	Integration step size in quasitime.	/D		2)	AL4 I NARC MADAMS RKUTT1 RKUTT2 SALVE WRAPUP	M I I I	H H H H H DT
IARC .	I	A	Subarc number.	/CMTRL	,	24)	ARCIN BCONO BNDRY BRANPT CHECK BCOSTAI ENDPT FORCES INTRPT MARCIN QLTOSZ SALVE WRAPUP	MINITIAL	I ARCCIARCCIARCCIARCCIARCCIARCCIARCCIARC
		I	A 10x20 array containing the initial condition codes for the QL state vector. The columns correspond to subarc starting points, the rows, to QL state variables.	/BLOCK	<i>1</i> (1)	BCOND BRANPT CHECK COSTAB COSTAI COSTAO INTRPT SALVE	I I I I I	11C 11C 11C 11C 11C 11C 11C
11CT			A 10:20 array containing the target condition codes for the state vector. The columns correspond to the subarc end points. The nonzero entries in a column are the state target condition codes that apply at the end of the corresponding subarc.	/BLOCK	/(20		CHECK COSTAB COSTAI COSTAO MAGIC SALVE	# 0 0	11CT 11CT 11CT 11CT 11CT
INDX		0	An array of four mords that indicate to Adams- Moulton integration in what order the derivatives of the particular and homogeneous solutions are stored.	/CNTRL	/(1		BCOND MADAMS Salve	A .	I NDX I NDX I NDX
IPFLG1			IPFLG1±0 supresses print-out of velocity losses and inertial Euler angles.	/GLOBA	L/(6		OUTPUT PDBCQL QLTOSZ SALVE	0	IPFL61 IPFL61 IPFL61

FORTRAN	HATH	CODE	DESCRIPTION	STOR	AGE	SUBROUT	INE USAG
SYMBOL	SYMBOL		DESCRIPTION	BLOCK	LOC	SUBA C	DDE VAR
ITAPB		1	Number of the logical unit onto which the quasitime histories of the particular and homogeneous solutions from the current QL iteration are prittem.	/CNTRL /	(4)	GROPE Salve	
JAKE		6	An 18x18 array defined by Equation 17.5-5 in Yol.] of this document. The entry in the i-th row and j-th column is the total partial derivative of the quasitime derivative of the Y ₁ component of Y with respect to the Y ₂ component of Y, i.e., $\frac{\partial Y_1^{\top}}{\partial Y_1^{\top}},$ where $\frac{\partial Y_1^{\top}}{\partial Y_1^{\top}}, \lambda^{\top}$	/JAC08 /	(1)	NLDRV	JAKE JAKE
KPT		M 1	The subarc point number. KPT = 1 on the first point of subarc, and KPT = MPTS om the last point of the subarc.	/CNTRL /	(8)	BCOND BNDRY FORCES MAGIC RKUTTI SALYE WRAPUP	KPT KPT KPT KPT KPT KPT KPT KPT KPT
-	• -			/D //	97)	AL4 AL7 AL8 AL9 BRANPT COST AB COST AB COST AT INTRU BLORY OUTPUT SALVE SALVE WRAPUP	
10 A			The number of homogeneous solutions currently being integrated.	/CNTRL /	9)	GROPE (INARC (LINDRY) NOMNAL 1 SALVE (WRAPUP (N 00 A 1 N 0 A 1 N 0 A 1 N 0 A
			otal number of QL state and costate variables. N : 18.	/PC /	2)	BMDRY : CHECK : IMARC : LIMDRY : NLDRY : NCMNAL : RKUTT1 : SALVE : WRAPUP :	M M M M M M M M M M M M M M M M M M M
NAR C	Ng	1 N	fumber of subarcs in the problem.	/GLOBAL/	18)	BCOND BNDRY CHECK CHECK ENDPT ENVPRO FETCH I NARC I NARC CHECK CHE	MARC NARC NARC NARC NARC NARC NARC NARC
N B R A M	NI	₽	iumber of the last subarc on the stem of a branch roblem. If the problem is not a branch problem, hen NBRAM = Q.	/GLOBAL/(19)	BNORY I BRANPT I COSTAB I ENVPRO I INTRPT I MAGIC I QLTOSZ I SALVE I	NBRAM NBRAM NBRAM NBRAM NBRAM NBRAM

FORTRAN .	MATH Symbol	CODE	DESCRIPTION	. <u>ST</u>	TORAGE K LOC	SUBFOUTINE !	USAGE RAV
-							
REWNOM		0	A logical flag that indicates to the Runge-Kotta integration shether or not the system Jacobian needs to be reevaluated.	/ CMTRL	. /(15	LINDRY M NE RKUTTI O NE SALVE O NE	MENUS MONWS MONWS MONWS MONWS
MFARC	N ₂		Number of the last subarc on the first branch. If the problem is not a branch problem, then NFARC = NARC.	/GLOBA	L/(20	BNDRY I NF BRANPT I NF COSTAB I NF ENVPRO I NF INTRFT I NF MAGIC I NF OLTOSZ I NF	ARC ARC ARC ARC ARC
新 拉	-		The number of quantities currently being numerically integrated.	/CNTRL	/(52: -	BNDRY M NA IMARC M NA MADAMS I NA MAGIC M NA	
MOC	-		An array containing a running total of the number of free (unknown) state and costate variables at the start of each subarc.	/BLOCK	/(842)	BRANPT I NO BRANPT I NO COSTAB O NO COSTAI O NO	C
	•			, -		COSTAGO NO INARC I NO INTRPT I NO SALVE I NO WRAPUP I NO	000
NOPRNT		0	Not used.	/CNTRL	/(29)	SALVE 0 NO	PRNT PRNT RNT
MPOINT			A twenty word array containing the number of points in each subarc.	/D	/(191)		CINT CINT
MPTS -		A	The total number of points in the subarc.	/CNTRL	/(.19)	BCCND O NP BNDRY O NP FORCES I NP INARC M NP MAGIC O NP SALVE M NP WRAPUP O NP	TS TS TS TS
VALTC		•	A 10x20 array containing the desired values of all the fixed (known) QL state variables. The columns correspond to the subarc starting points, the rows, to QL state variables.	/BLOCK	/(862)		FIC FIC
x		A	The quasitime variable.	/D		AL4 I I BNDRY O X EFROR I X FETCH O X FORCES I X INARC M X INTERP I X MADANS M X	
		•	-			RKUTTI M X RKUTT2 M X SALVE M X STATEF I X WRAPUP M TT	
X I		0 4	A four mord array containing the first four values of quasitime in the subarc.	/0	/(3)	INTERP I XI SALVE O XI	

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V	

FORTRAN SYMBOL	MATH SYMBOL	CODE	DESCRIPTION	3L	STORA OCK -	êE LGC			USÁGE Van
Y		, , ,	An 820 word array containing the particular and bemogeneous solutions being integrated. The first 18 words comprise the particular solution. Each block of 18 words thereafter comprises an independent nomogeneous solution.	/¥	/(, 1)	GROPE INARC MADAMS OLTOSZ RKUTTI SALVE WRAPUP	I A A	Y
z	Z		A 20 mord array used to store the total linear solution from the preceding SL Iteration.	/2			BNORY BRANPT ENOPT ENYPRO INTERP INTERP LINGRA NORNAL OUTPUT RKUTTA	I 0 I I A I .	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Z 1		И	A 2029 array containing the first four values of Z	/21	/(RKUTTZ SALVE WRAPUP INTERP	A A	Z Z Z Z I
ZSAVE			in the present subarc.	43	,,		SALVE	n i	Z I Z I
	•		A twenty word array containing the values from the initial arc of the state and costate at the initial point of the trajectory.	/3	,(-	BCOND BRANPT COSTAB COSTAI INTRPT POSCOL SALVE	I :	ZSA1E ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE ZSAVE



SUBRØUTINE SPLINE



Purpose

SPLINE interpolates the univariant tabular functions. In addition, it computes the first and second partials of these functions by evaluating the derivatives of the cubic spline interpolating function.*

^{*}See Section 17.7 of Vol. I.

```
SUBROUTINE SPLINE(IT, T, F, DFDX, D2FDX2)
                                                                                                                                                                                                       SPLINE
                                                                                                                                                                                                      SPLIME
SPLIME
SPLIME
SPLIME
SPLIME
SPLIME
SPLIME
SPLIME
SPLIME
SPLIME
SPLIME
   2.
3.
            00000
                                                                THIS ROUTINE PERFORMS THE NATURAL CUBIC SPLINE INTERPOLATION AT THE PT T OF THE FUNCTION WHICH IS TABULATED IN TABLE NO. IT.
  4.
                    EXTERNAL NUCASE

COMMON /TABLE/ TABLE(2100) /GLOBAL/ G(66)

DIMENSION X(1), Y(1), Z(1), LOCI(1), LOCL(1), LOCF(1)

EQUIVALENCE (X, TABLE), (Y, TABLE(701)), (Z, TABLE(1401)),

*(LOCI X), (LOCL, Y), (LOCF, Z), (NT, G(66))

DATA SIXTM/17155252525252525258/

DATA SPLINT /6NSPLINE/

10 FORMAT(110, 22HTHE TABLE NO. IN LOC. 06 17H IS OUT OF RANGE.)

20 FORMAT(110, 22HTHE TABLE NO. IN LOC. 06 20H HAS NOT BEEN INPUT.)

**ARKE SURE TABLE NO. WITHIN RANGE.**

IF(IT LE. NT) GO TO 100

ITLOC = XLOCF(1T)

MRITE(6, 10) ITLOC

CALL ERROR(SPLINT, -1, 1)

$70P
10.
                                                                                                                                                                                                      SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
6.
            C
                                                                                                                                                                                                                          100-
                 100 1F(1T .LE. 0) 60 TO 110

NON-ZERO TABLE NO. MAKE SURE IT WAS INPUT

II = LOCI(IT)

IF(II .GT. 0) 60 TO 120

ITLOC = XLOCF(IT)

WRITE(6, 20) ITLOC

CALL ERROR(SPLINT, -2, 1)

STOP
                                                                                                                                                                                                      SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
                                                                                                                                                                                                                         110-
13.
24.
26.
27.
29.
                                                                                                                                                                                                                                        120-7
                                                                                                                                                                                                       SPLINE
                                                               ZERO TABLE NO. SEND BACK CONSTANT ZERO FNC.
                 110 F = 0.

DFDX = 0.

D2FDX2 = 0.

RETURN
                                                                                                                                                                                                      SPLINE
SPLINE
SPLINE
SPLINE
31.
32.
33.
                 120 IF = LOCF(IT)
                                                                                                                                                                                                      SPLINE
35.
36. C
                            WHAT KIND OF FUNCTION IS F.

IF(1F - 1I - 1) 130, 140, 150

CONSTANT FAC.
                                                                                                                                                                                                      SPLINE
SPLINE
SPLINE
                                                                                                                                                                                                                          130-140
87.
                                                                                                                                                                                                     SPLINE
SPLINE
SPLINE
SPLINE
                  130 F = Y(11)

DFDX = 0.

D2FDX2 = 0.
39.
40.
41.
42.
                            RETURN
                                                               LINEAR FNC.
                                                                                                                                                                                                      SPLINE
                           Y1 = Y(||1)
X1 = X(||1)
DFDX=(Y(||F) - Y1)/(X(||F) - X1)
F = Y1 + (T - X1)+DFDX
D2FDX2 = 0.
                                                                                                                                                                                                     SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
<del>43.</del>
45.
46.
47.
48.
                                                               NONLINEAR FNC. IS T.GT. FIRST TABLE ENTRY.
                                                                                                                                                                                                      SPLINE
                                                                                                                                                                                                     SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
                150 IF(T .GT. X(II)) GO TO 160
NO. LINEARLY EXTRAP. FOR F(T)
51.
          C
52.
53.
                           94.
99.
96.
97.
58.
59.
60.
                                                                                                                                                                                                      SPLINE
                                                                                                                                                                                                      SPLINE
                                                               IS T .LT. LAST ENTRY IN TABLE.
                                                                                                                                                                                                     SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
SPLINE
62.
                160 IF(T .LT. X(IF)) GO TO 170
NO. LINEARLY EXTRAP. FOR F(T)
                           NO. LINEARLY EXTRAP. FOR FC1

1FM1 = IF - 1

Y1 = Y(IF)

X1 = X(IF)

DEL = X1 - X(IFM1)

DFDX=(Y1 - Y(IFM1))/DEL+ SIXTH=Z(IFM1)+DEL

F = Y1 + (T - X1)+OFOX

D2FDX2 = 0.

RETURN

FIMO TABLE SPECIAL STRAPS
54.
65.
66.
69.
10.
11.
                                                               FIND TABLE ENTRIES THAT BRACKET T.
          C
```

73. 74. 75. 76. 170 IL = LOCL(IT) IF(T - X(IL)) 180, 220, 190 SPLINE SPLINE 180-190-220-180 IL = IL - 1 IF(T - x(IL)) 180, 210, 210 190 IS = IL + 1 00 200 I = IS, IF IF(T - x(I) LT. 0.) 60 TO 210 200 IL = I 210 LOCL(IT) = IL SPLINE SPLINE 180-77. 78. 79. 80. SPLINE SPLINE SPLINE SPLINE 210 SPLINE 81. 87. 88. 89. 90. 91. 92. 93. 94. 95. -

DRTRAN Symbol	MATH Symbol	CODE	DESCRIPTION	BLOCK	LOC	SUBFOUTING SUBF COL	
LOCF		1	A 50 word array that corresponds to tables 1 thru 50. Each entry 1s an integer that points to the last value of the independent variable of the corresponding table.	/TABLE /(1401)	SPLIME I SPLIME I	LOCF
roc1		1	A 2100 word array used for storing up to 50 spline fitted universant tables.	/TABLE /(13	SPLIME I	X LOCI
LOCL		M	A 50 mord array that corresponds to tables 1 thru 50. Each entry is an integer that indicates the last interval in mhich interpolation of the corresponding table occured.	/TABLE /(701)	SPLINE N	LOCK
MT		1	Largest univariant table number in this case.	/GLOBAL/(66)	SPLINE 1	NT
x		1	A 2100 mord array used for storing up to 50 spline fitted univariant tables.	/TABLE /(1)	SPLINE I	X Loci
٧		1	A 50 word array that corresponds to tables 1 thru 50. Each entry is an integer that indicates the last interval in which interpolation of the corresponding table occured.	/TABLE /(701)	SPLINE N	A FOCF
2		ī	A 50 mord array that corresponds to tables 1 thru 50. Each entry is an integer that points to the last value of the independent variable of the corresponding table.	/TABLE /(1401)	SPLIME I SPLIME I	LOCF

SUBRØUT I NE STATEF

```
1.
2.
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5.
                                                                                                                                                                                                                                              STATES
                                    SUBROUTINE STATEF
               0000
                                                                                                                                                                                                                                              STATEF
                                                                              THIS ROUTINE COMPUTES ALL DYNAMIC QUANTITIES WHICH BEAR NO EXPLICIT DEPENDENCE ON THE CONTROL
                                                                                                                                                                                                                                               STATEF
                                                                                                                                                                                                                                             STATEF
GLOBAL
GLOBAL
GLOBAL
GLOBAL
GLOBAL
ARCOAT
                                COMMON/GLOBAL/
+GR FR OMGZ XLAMRF, YMURF LUM TO EPSLON, INNER
*ITRMAX_JJOP(6) IFATAL, NARC NBRAN NFARC ID(4) KTAB(20),
*ITAB(20), SIG_MAXTAB GM, PSIRF , IPFEGI , IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, IPFEGZ, INARK, KGLOBL(7)
*SREF ,EJ, XISP ,TRULT ,DINC ,DIPI
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            1.
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                                                                            GLOBAL
GLOBAL
GLOBAL
            6.
1.
8.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GLUBAL
GLUBAL
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JAER
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MXCG
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,IMODE
,HDMAX
,MAEC
,MISP
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MAEA
MAEG
MUDB
                                            **IATM | THODE | JAER | JPRO | GRAX | GRAX | MARCHANX | MOMAX | GROUT | ALFMAX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHANX | MARCHAN
                                                                               +XLMAX
+MAEB
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  13.
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76.
77.
78.
79.
                                                            SINZRO = SINZRO + SINZRO
COSZRO = (COSRHO + SINRHO)*(COSRHO - SINRHO)
R = ALT + ER
                                                                                                                                                                                                                                                                                                                                                                                      STATEF
                                                                                                                                                                                                                                                                                                                                                                                     JUL21
STATEF
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                                                                                                                            GRAVITY AND ITS PARTIALS.
                                                    G = GM/R**2
GM = -G/R
GM = -G/R
GM = -GM/R
GRR = -GM/R
GRR = -GRR + GRR
M = GR**
M = - XARC
TIME = TSTART + XX*TAU
TIMES = TIME - TSTAGE
IS THIS FREE FALL.

IF(KODE .EO. 0) RETURN
NO. COMPUTE ATMOSPHERIC AND/OR THRUST AFFECTS
NO. COMPUTE ATMOSPHERE
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81.
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                            C
      91.
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                                       101 CALL ANL625(ALT, TAMP, RORRR, 1DAM)
60 TO 104
                                                                                                                                                                                                                                                                                                                                                                                      STATEF
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     95.
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                                        102 CALL ANL63P(ALT, TAMP, RORRR, IDAM)
GO TO 104
                                                                                                                                                                                                                                                                                                                                                                                      STATEF
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                                                                                                                                                                                                                                                                                                                                                                                                                              104
     98.
99.
                                                                                                                            VACUUM. CHECK FOR CG TRACK.
                                        103 IF(JAER - 2) 108, 108, 107
COMP. MACH AND DYNAMIC PRESSURE
   100.
                                                                                                                                                                                                                                                                                                                                                                                      STATEF
                                                                                                                                                                                                                                                                                                                                                                                                                                                    107
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        108
                                      104 MACH = V/C5
FCTR = V+V/2.
-- 9- =-FCTR=R0
  102.
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  103.
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STATEF
STATEF
                                                          IS REFERENCE AREA POSITIVE

IF(SREF .LE. O.) GO TO 108

YES. COMPUTE PARTIALS OF MACH AND DYN. PRESSURE
                            C
  106.
107.
109.
109.
110.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             108-
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STATEF
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                            C
                                                          MACHY = 1./CS
MACHR = -MACH+MACHY+CSR
                                                        MACHR = -MACH*-MACH*-CSR
MACH*R = MACH*-CSR
MACH*R = MACH*-CSR
MACH*R = -MACH*-CSR
MACH*R = -MACH*-(MACHRR + MACHRR + MACH*-CSRR)
QY = V*RO
QR = FCTR*-ROR
QVY = V*ROR
QRR = FCTR*-RORR
LIS THIS BIVARIANT AERO.
                                                                                                                                                                                                                                                                                                                                                                                      STATEF
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 113.
114.
11b.
                                                                                                                                                                                                                                                                                                                                                                                       STATEF
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STATEF
STATEF
                                                       QVR = V+ROR

ORR = FCTR+RORR

IS THIS BIVARIANT AERO.

IF(JAER .EQ. 2) GO TO 108

NO. UNIVARIANT. COMPUTE COEFFICIENTS NEEDED FOR LINEAR AERO MODEL.

CALL SPLINE(MAER, MACH, CLA, CLAM, CLAM)
CALL SPLINE(MAEC, MACH, CDO, CDOM, CDOM)
CALL SPLINE(MAEC, MACH, CDO, CDOM, CDOM)
CALL SPLINE(MAEC, MACH, FK, FKM, FKMM)
CLA = CLAM-DEG
CLAM- CLAM-DEG
CLAM- CLAM-DEG
IS MOMENT BALANCING CALLED FOR.

IF(JAER .EQ. 1) GO TO 108

VES. CHECK TO SEE IF DUST SIMPLE CG TRACK

IF(DREF .LE. 0.) GO TO 105

NO. UNTRIN AERO DATA. COMPUTE COEFF. NEEDED FOR MOMENT BALANCING
CALL SPLINE(MAEC, MACH, CMA, CMAM)
CALL SPLINE(MAEC, MACH, CMA, CMAM, CMAMM)
CAL SPLINE(MAEC, MACH, CMA, CMAM, CMAMM)
CMA = CMAM-DEG
CMAM = CMAM-DEG
CMAM = CMAM-DEG
                          C
                                                                                                                                                                                                                                                                                                                                                                                     STATEF
STATEF
STATEF
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 120.
121.
122.
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  123.
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   1 30 .
                            C
 131.
132.
133.
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STATEF
                            C
134.
126.
136.
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                                                                                                                                                                                                                                                                                                                                                                                    STATEF
STATEF
STATEF
                                                         CHAMM = CHAMM*DEG
IS THIS POWERED FLIGHT
                                                                                                                                                                                                                                                                                                                                                                                      STATEF
                                    105 IF(IPOW .EQ. 0) GO TO 107

YES. COMPUTE BLEND FACTOR AND PARTIALS.

10 CALL SPLINE(MARG, Q, XJ, XIQ, XIQQ)

IF(XJ, LT. 0. .OA. 1. Lt. XJ) CALL ERROR(XSTATF, -1, 1)

XJV = XIQ+QV

XJR = XIQ+QV

XJVR = XIQ+QVV + XIQQ+QV+QV

XJVR = XIQ+QVR + XIQQ+QV+QR
141.
                                                                                                                                                                                                                                                                                                                                                                                    STATEF
  142. C
                                                                                                                                                                                                                                                                                                                                                                                    STATEF
STATEF
STATEF
STATEF
 143.
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49. 50. C	XJRR = XJQ+QRR + XJQQ+QR+QR COMPUTE CG COORDS, AND THEIR PARTIALS	STATEF STATEF	
51. 107 52. 53. 54.	CALL SPLINE(MXCG, W, XCG, XCGM, XCGMM) CALL SPLINE(MZCG, W, ZCG, ZCGM, ZCGMM) XCGM = XCGM+GR ZCGM = ZCGM+GR	STATEF STATEF STATEF STATEF	
>> . >• . c	ICGMM = ICGMM+GR+GR ICGMM = ICGMM+GR+GR IS THIS POWERED FLIGHT	STATEF STATEF STATEF	
	IF(IPOM .EQ. 0) RETURN YES. IS VACUUM THRUST TABULAR. YES. ARE WE POWERED BY AIRBREATHER IF(J) .NE. 4) GO TO 1081 AIRBREATHER. COMPUTE THRUST AND SPEC. FUEL CONSUMP. CALL BLIME(V, ALT, TAIRB)	JUL21	1081
6. 1081	GO TO 1082 NOT AIRBREATHER. IS VAC. THRUST TABULAR. IF(MTT .LE. 0) RETURN IF(MTT .LE. 0) RETURN	JUL21 JUL21 STATEF	1082
C C	YES. COMPUTE NOMINAL, I.E. UNTHROTTLED, VACUUM THRUST CALL SPLINE(HTT, TIMES, FVAC, FVACT, FVACTT) IF(FVAC LT. 0.) CALL EAROR(XSTATF, -2, 1)	STATEF STATEF STATEF STATEF	
2. 3. •	FVAC = THULT=FVAC FVACT = THULT=FVACT=XX FVACTT = THULT=FVACTT=XX==2 COMPUTE BASE DRAG IF INPUT.	STATEF STATEF STATEF STATEF	
	IF(IPOM .EQ. 2) CALL SPLINE(ADB, ALT, DB, DBR, DBRR) RETURN END	JUL21 STATEF STATEF	
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FORTRAN Symbol	MATH Symbol	COD	DESCRIPTION		BLOCK L		E SUBPOUTI		ODE	NE USAG	
		•					_				
ALT	h	i	Altitude	(FT)	/D	/(94)	OUTPUT Statef Wrapup	I	ALT ALT	
CDO	c ^{DO}	1	Drag coefficient at a = 0		/DYNA	/(104)	AEROCO STATEF		CD0	
CDOM	ac _{Do} /am	I	See symbol		/DYNA	*(105)	AEROCO STATEF		CDO	
CDOMM	$\partial^2 C_{D_0} / \partial M^2$	I	See symbol		/DYNA	/(145)	AEROCO Statef		CD0/	
CLA	c _L	•	Lift coefficient slape	(RAD-1)	/DYNA	10	187)	AEROCO Statef	R R	CLA CLA CLA	
CLAM	ac _{Le} /am	•	See symbol		/DYNA	/(191)	AERÔCO Statef	M M	CLAI	
CLAMM	a²C _{Le} ∕am²	R	See symbol		/DYNA	/(146)	AEROCO Statef	ı	CLA	
CLO	r ^o	ţ	Lift coefficient at a = 0		/OYNA	10	106)	AEROCO STATEF	1	CLO	
CLOP	ac <mark>ro</mark> ∕aw	1	See symbol		/DYNA	/(147)	AEROCO STATEF	J	CLOI	
CLOMM	a²c _{Lo} ∕am²	ī	See symbol		/DYNA	/(148)	AEROCO STATEF	1 (CLO	
CMA	c ^a	- M-	Moment coefficient slope	(RAD-1)	/DYNA	/(123 >	ROMECO STATEF	I I	CRA Cra Cra	
CMAM	76\ _# 26	M	See symbol		/DYNA	71	127)	MDMECD STATEF	1 1	CMA CMA CMA	
CHARR	∂ ² C _# /∂M²	8	See symbol		/DYNA	11	131)	MOMECO STATEF	1	CMA CMA	
CMO	c,	I	Moment coefficient at a = 0.		/DYNA	/(128)	MOMECO STATEF	1	CMO CMO	
CMOM	75 me/ ₀ 26	1	See symbol		/DYNA	/(129)	MOMECO STATEF		CMO	
CMOMM	a ² C _{mo} /am ²	1	See symbol		/DYNA	/(130)	MOMECO	. (CMO CMO	
CO5GAM	C 0 8 7	n	See symbol		/DYNA	/(4)	AL4 AL7	I (0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	CMOI COSI COSI COSI COSI COSI COSI COSI	
COSPSI	cos♥	0	See symbol		/DYNA	/(95)	ALT ALB		051 051 051 051 051 051	
COSRMO	C 0 8 p	Ħ	See symbol		/DYMA	/(97)	AL4 AL7 AL8 AL9 CONTRL NLDRY OUTPUT POBCOL		05	

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FORTRAN Symbol	MATH Symbol	COB	• DESCRIPTION	DESCRIPTION STORAGE BLOCK LOC					SUBROUTINE USAS				
		****	·										
COSZGM	cos27	0	See symbol		/DYNA	/(121)	AL4 I STATEF O					
COS2RO	c o s 2 p	0	See symbol		/DYNA	/(120)	AL4 I AL7 I AL8 I NLDRV I STATEF O	COSZRI COSZRI COSZRI				
CS	•	1	Speed of sound	(FT/SEC)	/DYNA	/(16)	OUTPUT I					
CSR	0 m / 0R	1	See symbol		/DYNA	70	26)	STATEF I	CSR				
CSRR	∂ ² a/∂R ²	1	See symbol		/DYNA	/(24)	STATEF I	CSRR				
DB	D _b	1	Base drag	(LBS)	/DYNA	/(163)	AL1 I AL4 I AL6 I AL7 I AL8 I AL8 I AL9 I	08 08 08 08 08 08 08 08 08				
OBR ,	∂D _b /∂R.		Şee symbol	• • •	/DYNB	π.	86)	AL1 I AL4 I AL6 I AL7 I AL8 I AL9 I APPLY I STATEF I TH3 I UT I	DBR DBR DBR DBR DBR DBR DBR DBR DBR				
DBRR	∂ ² 0 ₆ /∂R ²	1	See symbol		/DYNA	/t	87)	-	DBRR OBRR OBRR OBRR OBRR OBRR OBRR OBRR				
DREF	Dref	1	Aerodynamic reference length		/ARCDA	T/C	37)	STATEF 1	DREF				
ER	ER	I	Earth radius.	(FT)	/GLOBA	L/(ENVPRO I PDBCOL I OLTOSZ I STATEF I	ER ER ER ER				
FK	k	1	Induced drag coefficient		/DYNA	/(AEROCO I Statef i	FK FK				
FKM	ak/am	1	See symbol		/DYNA	/(182)	AEROCO I Statef I	FKM FKM				
FKMM	∂²k/∂M²	1	See symbol		/DYNA	/(183)	AEROCO I Statef I	FKAA FKAA				
FVAC		A	Total vacuum thrust (rocket)	(LBS)	/DYNA	/(33)	APPLY I ARCIN M IMPULS M NLDRY I STATEF M	FVAC FVAC FVAC FVAC FVAC				
								TH2 I	FVAC				

FORTRAN SYMBOL	FIATH Symbol	CODE	DESCRIPTION	BLOCK	LOC	SUBROUTINE USAGE C SUBR CODE VAR				
FVACTT		Ħ	Not used.	/DYNA /(41)	ARCIN I FVACTI STATEF M FVACTI TH2 I FVACTI				
G	g	n	Instantaneous gravitational acceleration $({\it FT/SEC}^2)$	/DYNA /(8)	AL4 I G AL7 I G AL8 I G AL9 I G CONTRL I G NLORY I G STATEF M G				
GAM	7	I	Relative flight path angle. (RAD)	/D /(92)	ARCIM I GAM ENVPRO I GAM CUTPUT I GAM STATEF I GAM WRAPUP I GAM				
GH	∂g/∂R	n	See symbol .	/DYNA /(142)	AL7 I GH AL8 I GH NLDRV I GH STAYEF M GH				
GM	GM	ĭ	Product of Nemton's universal gravitational constant and the mass of the earth. $(\text{FT}^3/\text{SEC}^2)$	/GLOBAL/(67)	OUTPUT I GM PDBCOL I GM STATEF I GM				
G ₽	9,	ī	Gravitational acceleration at surface of the earth. (FT/SEC ²)	/GLOBAL/(1)	ALS I GR APPLY I GR BRANPT I GR CCSTAB I GR CCSTAI I GR CUTPUT I GR QUTPUT I GR QUTPUT I GR QUTOZI GR SALVE I GR STATEF I GR				
GRR	∂ ² g/∂R ²	*	See symbol .	/DYNA /(143)	AL7 I GRR AL8 1 GRR ALDRY I GRR STATEF M GRR				
IAT#		ī	Atmosphere option flag	/ARCDAT/(7)	ARCIN I IATM MLDRV I IATM GUTPUT I IATM STATEF I IATM				
IDAM		1	Optional atmospheric calculations flag. IDAM = -1: Compute $\partial^3 \rho_{a}/\partial R^3$; IDAM = 0: No optional calculations; IDAM = 1: Compute $\partial^3 \rho_{a}/\partial R^3$, μ_{a} , $\partial \mu_{a}/\partial R$, etc.	/DYNA /(218)	ARCIN O IDAM ERROR I IDAM NPLANE O IDAM STATEF I IDAM WRAPUP O IDAM				
IPOW		1	Powered flag. 1POW = 0: No thrust and no base drag IPOW = 1: Thrust, but no base drag IPOW = 2: Thrust and base drag	/DYNA /(139)	ARCIN M IPOW FORCES I IPOW NPLANE I IPOW STATEF I IPOW THROTL I IPOW				
JAER		1	Aerodynamic model option flag	/ARCDAT/(9)	AEROCO I JAER ARCIN I JAER OUTPUT I JAER STATEF I JAER UT I JAER				
וו		•	Thrust option flag. J1 = 1: Constant thrust; J1 = 2: Input vacuum thrust; J1 = 3: Powered total acceleration limit; J1 = 4: Air-breather engine.	/DYNA /(173)	APPLY I J1 ARCIM 0 J1 CONTRL M J1 FORCES I J1 MPLANE I J1 STATEF I J1 THROTL M J1				

FORTRAN	MATH	COD	■ DESCRIPTION		TORA		SUBROU	11] h	E USAGE
SYMBOL	SYMBOL		DESCRIPTION	BLOC	K	LOC	SUBR	COL	E VAR
KODE		I	Steering vector flag KODE = 0: Free fail, m = 0 = 0; KODE = 1: Both a and 0 optimal; KODE = 2: a optimal and 0 = 0; KODE = 3: a nonoptimal and 0 optimal; KODE = 4: Vertical rise or pitchover; KODE = 5: a nonoptimal and 0 = 0.	/DYNA	/(25)	APPLY ARCIN CONTRL FORCES NLDRY STATEF	I	KODE KODE KODE KODE KODE
n		ī	Mass (6'S) /0	/(97)	AL4 AL7 AL8 ALP LY BRANPT COSTABI COSTABI INTRY OUTPUT SALTE SHAPUP		**************
MACH	n	A	Mach number	/DYNA	/(26)	AEROCO ENVPRO DUTPUT STATEF	I ì	MACH MACH MACH MACH
MACHR	am/ar	M	See symbol	/DYNA	/(44}	STATEF UT		MACHR MACHR
MACHER	∂ ² m/∂R ²	Ħ	See symbol	/DYNA	/(118)	STATEF UT	Ħ I	MACHRA MACHRA
MACHV	9M/9V	n	See symbol .	/DYNA	/(43)	STATEF	Ħ	MACHY
MACHVR	a ² m/avaR	0	See symbol	/DYNA	/(117)	STATEF	0	MACHVI
MAEA		1	Curve number	/ AR CB	AT/C	18)	STATEF	Ţ	RAEA
MAEB		1	Curve number	/ARCD	AT/C	19)	STATEF	1	MAEB
MAEC		1	Curve number	/ARCD#	AT/C	20)	STATEF	I	MAEC
MAED		1	Curve number	/ARCDA	T/C	21)	STATEF	i	MAED
MAEE		1	Curve number	/ARCDA	T/C	22)	STATEF	I	MAEE
MAEF		1	Curve number	/ARCDA	1/(23)	STATEF	Ī	MAEF
MAEG		1	Curre number	/ARCDA	1/6	24)	STATEF	1	MAES
AD8		1	Curve number - base drag table	/ARCDA	17/	31)	ARCIN Statef	i I	MDB MDB
MTT		1	Table number for tabulated rocket vacuum thrust	/DYNA	/(172)	ARCIN Statef	ĭ	ATT ATT
MXC6		I	Curve number -xcg table	/ARCDA	1/(27)	STATEF	1	MXCE
MZCG		I	Curve number- zcg table	/ARCDA	1/(STATEF		MZC6
PSI	*	1	Relative azimuth angle. (RAD)	/0	/(93)	STATEF WRAPUP	I	PSI PSI PSI
1	9	R	Dynamic pressure (LBS/FT ²)	/BYNA	/(271	ENVPRO OUTPUT POBCOL	i I	@ Q Q
P	∂q/∂R	A	See symbol	/DYNA	/(29)	PDBCOL STATEF UT	I M I	GR GR GR
BRR	∂ ² q/∂R ²	n	See symbol	/DYNA	/(32)	STATEF		ORR ORR
. v	8q/8V	A	See symbol	/DYNA	/(28)	PDBCQL		0 V

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FORTRAN Symbol	MATH Symbol	COD	DESCRIPTION	BLOC	O R A	LOC	SUBROUT SUBA (ODE
QVR	∂ ² q/∂V∂R	Ħ	See symbol	/DYNA	'n	31)	STATEF	M Q1
0 v v	8 ² q/8 y ²	ĸ	See symbol	/DYNA	/(30)	STATEF	
R	Ħ	ĸ	Radial distance from earth center to vehicle (FT)	/ DYNA	,((7)	AL4 AL7 AL8 AL9 CONTRL ENVPRO NLDRV PDBCQL QLTOSZ STATEF	I R I R I R I R I R I R I R
RHO	ρ	I	Letituda (RAD)		/(95)	AL9 OUTPUT Statef Wrapup	I R
RO	Pa	1	Atmospheric density (SLGS/FT ³)	/DYNA	/(15)	AL8 AL9	I R
ROR _	. 90 ₈ /98	1	See symbol	/DYNĄ	/(ALS AL9 NLDRY PD&CQL STATEF	1 R
RORR	∂ ² ρ _a /∂R ²	1	See symbol	/DYNA	/(23)	ALB AL9	I R I R I R I R
RORRR	∂ ³ ρ _∎ /∂R ³	1	See symbol	/DYNA	/(213)	AL8	I R I R I R
SINGAA	sin7	R	See symbol	/ DYNA			AL4 AL8 AL9 CONTRL NLDRY PDBCQL STATEF	1 51 1 51 M 51
SINPSI	sin∳	0	See symbol	/DYNA	/(94)	AL7 AL8	1 51 1 51
SINRHO	sinρ	A	See symbol .	/DYNA	/(96)	AL7 AL8 AL9 Contrl	1 5

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FORTRAN Symbol	MATH Symbol	CODE DESCRIPTION	0 N	ST BLOCK	ORAG (LOC	SUBROL SUBR
S1#2R0	sin2p	A See symbol		/DYNA	/(119)	AL7 AL8 NLDRV
SREF	S _{ref}	1 Aerodynamic reforence area	(FT ²)	/ARCDA	T/(1)	STATEF ARCIN BNDRY CHECK FETCH SALVE STATEF UT WRAPUF
TAIRB		I Air-breather engine thrust	(LBS)	/DYNA	/(219)	STATEF
TAMP	T _a	I Atmospheric temperature	(DEG-R)	/DYNA	/(13)	TH4 STATEF
TAU	,	I Subarc duration	(SEC)	/B	/(98)	ARCEN INARC NLDRY OUTPUT STATEF
TIME -		# Trajectory time	(SEC)	/DYNA	/(2)	ENVPRO OUTPUT PDBCOL STATEF WRAPUP
TIMES		M Elapsed burning time of present ro	cket engine (SECS)	/DYNA	/(168)	STATEF
TAULT	Tmuit	I Thrust multiplier or number of eng	ines	/ARCDA	T/ (4)	ARCIN STATEF
TSTAGE		I Trajectory time at which present r ignited.	ocket engine (SECS)	/BYNA	/(167)	ARCIN STATES TRAJIA
TSTART		I Trajectory time at phich present s	sybarc commenced.	/DYNA	/(141)	ARCEN ARCIN STATEF TRAJIN
•	٧	I Relative velocity.	(FT/SEC)	/0	70		AL1 AL4 AL8 AL9 BCONDY BRANPT CONTPL ENVPRO FETCHP INTERP INTERP INTERP INTERP OUTPUT OUTPUT STATES WRAPUP
#		M Weight	(LBS)	/DYMA	/(AL5 ENVPRQ OUTPUT PDBCQL

FORTRAM SYMBOL	MATH Symbol	COD	DESCRIPTION		BLOC	OPAG	E LOC	SUBPOU SUBP	COD	E USAGE E VAR
x	•	I	The quasitime variable.		/B	/(n	AL4 BNDRY ERROR FETCH FORCES INATERP MADATT1 RKUTTE STATE WRAPUP		X X X X X X X X X X X X X X X X X X X
XARC		I	Quasitime at which present subarc commenced.		/DYNA	/ <u>(</u>	140,}	ARCIN Statef	O	IARC IARC
xce	Xcc	I	Center of gravity body z station	(FT)	/DYNA	/(157)	DL2 STATEF UT	1 1 1	XC6 XC6
XCGM	ax _{ce} /a₌	ĸ	See symbol		/BYNA	/(108)	DL2 STATEF UT	I A I	XCGM XCGM
XCGMM	∂²X _{CG} /∂m²	Ħ	See symbol		/DYNA	/(109)	DL2 Statef Ut	I A I	XCGMM XCGMM XCGMM
- XJ	j	- 1	Control blend factor		/DYNA	/(159)	ARCIN DL2 OUTPUT STATEF UT		x) x) x) x)
X JR	aj/aR	0	See symbol		/DYNA	/(113)	DL2 STATEF UT	1 0 1	XJR RLX RLX
ANCX	a ² j/aR ²	0	See symbol		/DYNA	/(116)	DL2 STATEF UT	1 0 1	XJRR RALK RALK
X I V	aj/av	0	See symbol		/DYNA	/(112)	DL2 Statef Ut	i 0 1	XIA ACX XIA
XJVR	a²j∕avaR	0	See symbol		/DYNA	/(115)	DL2 Statef Ut	1 0 1	XJ AB XJ AB XJ AB
XJAA	9 2 j/av²	0	See symbol		/DYNA	/(114)		1 0 1	AACX AACX Aacx
XX		A	Fraction of subarc that has transpired		/DYNA	/(1)	ARCIN ERROR OUTPUT STATEF		XX XX XX
ZCG	zce	I	Center of gravity body z station	(FT)	/DYNA	/(158)		I I I	ZC6 ZC6 ZC6
ZCGM	∂Z _{CG} /∂∎	A	See symbol		/DYNA	/(110)	DL2 Statef Ut	I M I	ZCGM ZCGM ZCGM
ZCGMM	∂ ² Z _{cg} /∂∎ ²	M	See symbol		/DYNA	/(111)	DL2 Statef Ut	1 # 1	ZCGMM ZCGMM ZCGMM

SUBRØUT I NE. THRØTL



THROTL determines whether the rocket thrust should be throttled in order to satisfy a total acceleration limit.

76. 778. 1901. 190



| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | ST
BLOC | ORA
K | LOC
LOC | | | USAGE
VAR |
|-------------------|------------------|------|--|------------|----------|------------|--|-------------|--------------------------------------|
| GMAX | G _{MAX} | 1 | Maximum total acceleration g load | / AR CDA | T/(| 12) | AL5
NPLAME
THROTL
TH3 | | GMAX
GMAX
SMAX
GMAI |
| IPOW | | 1 | Powered flag. IPOW = 0: No thrust and no base drag IPOW = 1: Thrust, but no base drag IPOW = 2: Thrust and base drag | /DYNA | /(| 139) | ARCIM
FORCES
NPLAME
STATEF
THROTL | 1 | IPOM
IPOM
IPOM
IPOM
IPOM |
| Jì | | A | Thrust option flag. J1 = 1: Constant thrust; J1 = 2: Input vacuum thrust; J1 = 3: Posered total acceleration limit; J1 = 4: Air-breather engine. | /DY#A | /(| 173) | APPLY
ARCIN
CONTRL
FORCES
NPLANE
STATEF
THROTL | I
I
I | J1
J1
J1
J1
J1
J1 |
| SWITCH | | | Logical flag that is true if this is the compute point at which the powered acceleration constraint commences. | /DYNA | /(| 184) | CONTRL
MPLANE
THROTL | 1 | SWITCH
SWITCH
SWITCH |
| XK1 | | I | First entry of 3 word in-plane control constraints
K | /MATS | /(| 4) | ALGCON
THROTL
TH1
TH2
TH3
TH4 | 0
0
1 | XK1
XK1
XK1
XK1
XK1 |

SUBRØUT I NE TH 1

Till evaluates the constant thrust constraint

$$T - C_T = 0.$$



```
SUBROUTINE THE
           2.
3.
4.
5.
                                                            THIS ROUTIME APPLIES WHEN MET THRUST IS A CONSTANT

LOGICAL SWITCH, ILOAD

REAL MACH, ISP, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, ISPN, IFTN, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, LIFTA, 
                                                                                                                                                                            THIS ROUTINE APPLIES WHEN NET THRUST IS A CONSTANT
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DYMA
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    13.
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DYNA
JUL21
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MATS
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73.
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590

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76.
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83.
84.
85.
65.
67.
                                  *PV ,PG ,PP ,PR 

*POV ,PGG ,PPG ,PRG 

*POR ,POO ,PLG ,PLP 

EQUIVALENCE(PRODI, PRODS)

ENTRY TH1002 

ENTRY TH1001 

40 XKIT = 1. 

ENTRY TH1000 

50 XKI = T - CT
                                                                                                                                                                       , P06
                                                                                                                                                                                                                                  PGV
                                                                                                                                                                                                                                                                 ,PPV
,POP
                                                                                                                                                                                                                                                                                               , PRV
, PRR
                                                                                                                                                                                                                                                                                                                                                 MATS
MATS
MATS
THI
THI
THI
THI
THI
THI
THI
                                                 RETURN
END
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| FORTRAN
Symbol | MATH
Symbol | COBE | DESCRIPTION | BLOC | ORA
K | GE
LOC | SUBRCU
Subr | TINE | USAG
VAR |
|-------------------|----------------|------|---|-------|----------|-----------|---|---|---------------------------------|
| СТ | CT | 1 | Value for thrust in case constant thrust constraint is used. (LBS) | /DYNA | /(| 150) | TH'I | 1 | CT |
| T | Т | I | Thrust (LBS) | /DYNA | | 42) | ALGCON
AL1
AL4
AL6
AL7
AL8
AL9
APPLY
ARCIN
CONTRL
DL2
IMPULS
OUTPUT
TM1
TM2
TM3
TH4 | 111111111111111111111111111111111111111 | T |
| XK1 | | 0 | First entry of 3 word in-plane control constraints K | /MATS | /(| 4) | ALGCON
THROTL
TH1
TH2
TH3
TH4 | 1
0
0
0 | XK1
XK1
XK1
XK1
XK1 |
| XK1T | K(1) | ٥. | First entry of 3x3 matrix containing the explicit partials of K mith respect to m, Km | /MATS | μ. | - 1) | ALGCON
TH1
TH2
TH3 | 0 | XK1T
XK1T
XK1T |



SUBRØUT I NE TH2

Til2 evaluates the unthrottled vacuum thrust constraint

$$T - F_{VAC} + A_E P_a = 0$$

In addition, it evaluates the explicit first and second partials of this constraint with respect to the state and control as they are needed.

2. 3.

4.

10.

41. 42. 43. 44.

40. 47. 48. 49.

50. 51. 52. 53.

50. 59. 60.

64. 65. 66. 67. 69. 70. 71. 72.

73. 74. 75.

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$ 6 P
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SUBROUTINE THE
0000
                                                LOGICAL SWITCH, ILOAD
REAL MACH, ISP, ISPN, ISPN, ISPM, ISPT, ISPV, ISPVR, ISPVR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPRR, ISPR
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TH2
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MATS
MATS
                                                             COMMON /MATS/

=XK100 XAZUD XK30D XK10A XK20A XK30A XK111 XK271

=XK17D XK27D XK30D XK10A XK20A XK30A XK111 XK271

=XK17D XK27D XK30D XK17A XK22A XK32A XK1VV XK2VV

=XK13V XK26V XK36V XK17V XK2PV XK3PV XK1NV XK2VV

=XK10V XK20V XK30V XK10V XK2PV XK3PV XK1NV XK2PV

=XK10V XK20V XK30V XK10G XK20G XK30G XK10G XK2PG

=XK10X XK27G XK37G XK10G XK20G XK30G XK10G XK2PG

=XK18A XK27G XK37G XK10G XK20G XK30G XK10F XK2PF

=XK18A XK27A XK38P XK10G XK20G XK30G XK10F XK2PF

=XK18P XK27P XK38P XK10P XK20P XK30P XK10P XK2PP

=XK18P XK27P XK38P XK10P XK20P XK30P XK10P XK2PP

=XK18P XK27P XK38P XK10P XK20P XK30P XK10P XK2PP

=XK18P XK27P XK38P XK10P XK20P XK30P XK10P XK2PP

=XK18A XK27A XK30R XK10A XK20D XK30D XK10D XK20D

=XK18A XK27A XK30R XK10A XK27D XK31D XK10D XK20D

=XK18A XK27A XK30R XK10A XK27D XK31D XK10D XK20D

=XK18A XK27A XK37A XK10A XK27D XK31D XK10D XK20D

=XK18A XK27A XK37A XK10A XK27D XK31D XK10D XK20D

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=XK17A XK27A XK37A XK10A XK27A XK37D XK10A XK20A

=XK17A XK27A XK37A XK17A XK27A XK37D XK10A XK27A

=XK17A XK27A XK37A XK17A XK27A XK27A XK711 XK7121

=XK7112 XK712 XK712 XK713 XK7123 XK7133 XK7113 XK7121

=XK7112 XK712 XK712 XK713 XK7123 XK7133 XK7133 XK7123 XK7133 XA11A XK7121

=XK711A XK27A XK37A XK17A XK712 XK713 XK713 XK7123 XK713 XK7111 XK7121

=XK711A XK712 XK713 XK713 XK7123 XK7133 XK713 XK7133 XK7133 XX711A

=XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A XM17A
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XK3UG
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XK3UP
XK3RR
XK3RR
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, XK3UU
, XK3MM
                                                                  -DPDV(3, 8), DEPDEV(2, 8), DPDL(3, 3), PROD5(3, 64), PROD9(2, 24)
COMMON /MRTS/
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6 DET 72 6.01-44

| FORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | ST
BLOCK | ORAGE
K LOC | SUBROUTIA
SUBR COO | E USAGE |
|-------------------|-----------------------------------|---|-------------|----------------|---|--|
| AE | A _{exit} | I Total mozzie esit area (FY ² |) /DYNA | /(89) | APPLY I
ARCIN O
IMPULS I
NLORY I
TH2 I | AE
AE
AE
AE |
| FVAC | | I Total vacuum thrust (rocket) (LBS |) /DYNA | /(33) | APPLY I
ARCIN M
IMPULS M
NLDRY I
STATEF M
TH2 I | FVAC
FVAC
FVAC
FVAC
FVAC
FVAC |
| FVACT | | 1 Wot used. | /DYNA | /(37) | ARCIN 1
STATEF M
TH2 I | FVACT
FVACT
FVACT |
| FVACTT | | I Mot used. | /DYNA | /(41) | ARCIN I
STATEF M
TH2 I | FVACTT
FVACTT
FVACTT |
| PA | Pa | I Atmospheric pressure (LBS/FT ² |) /DYNA | /(14) | IMPULS I
NLORV I
OUTPUT I
TH2 I | PA
PA
PA
PA |
| PAR | aP_/aR | I See symbol | /DYNA | /(18) | APPLY I | PAR
Par |
| PARR | a ² P_/aR ² | I See symbol | /DYNA | /(22) | APPLY I | PARR
PARR |
| T | Ť | I Thrust (LBS |) /DYNA | /(~42) | ALGCON MALA I ALA I ALA I ALA I ALB I ALB I ALB I ALB I ARCIN O CONTRL M DL2 I I MPULS I OUTPUT I TH1 I TH2 I TH3 I TH4 I I TH3 I TH4 I | ************************************** |
| XK1 | | O First entry of 3 word in-plane control constraints
K | /MATS | /(<u>j</u> 1) | ALGCON I
THROTL I
TH1 O
TH2 O
TH3 O
TH4 O | XK1
XK1
XK1
XK1
XK1 |
| XKIRR | K(1) | O The first entry in a 3x5 matrix containing Kyh | /MATS | /(205) | TH2 0
TH3 M
TH4 0 | XKIRR
XKIRR
XKIRR |
| XKIT | K(1) | O First entry of 3x3 matrix containing the explicit partials of K mith respect to m, K _m | /MATS | /(7) | ALGCON I
TH1 0
TH2 0
TH3 M | XK1T
XK1T
XK1T |
| XK1ZZ | K(1) | 0. The first entry in a 3x1 matrix containing $\kappa_{y\nu}$ | /MATS | /(247) | | XK1ZZ |



SUBRØUTINE TH3



TH3 evaluates the powered total acceleration constraint

$$(T\cos(\alpha-\delta_E) - D_B\cos\alpha-D)^2 + (T\sin(\alpha-\delta_E) - D_B\sin\alpha+L)^2$$
$$- (g_{max}W)^2 = 0$$

In addition, it computes the explicit first and second partials of this constraint with respect to the state and control as they are needed.

```
1.
2.
3.
4.
                                                                                                                                  SUBROUTINE TH3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TH3
TH3
TH3
TH3
TH3
                                                                                                  0000
                                                                                                                                                                                                                                                                                         THIS ROUTINE APPLIES WHEN THRUST IS THROTTLED
                      ١.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    GLOBAL
GLOBAL
GLOBAL
                      6.
6.
8.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    GLOBAL
GLOBAL
ARCDAT
          10.11.12.13.14.15.16.17.18.19.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ARCDAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ARCDAT
ARCDAT
ARCDAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ARCDAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ARCDAT
ARCDAT
ARCDAT
ARCDAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DYNA
DYNA
DYNA
          21.
22.
23.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DYNA
DYNA
GYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DYNA
        20.
30.
31.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TILINA
DOYNNA
DOYNNA
DOYNNA
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DOYNNA
      32.
33.
34.
35.
36.
37.
38.
      40.
41.
42.
43.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DYNA
      44 .
45 .
46 .
47 .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DYNA
DYNA
DYNA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DOUND DOUND TO THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF
49.

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51.

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55.

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64.

64.

64.

64.

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67.

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72.

73.
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77.
18.
    19.
   82.
  83.
84.
85.
88.
89.
91.
93.
95.
98.
                                                                  THIS ENTRY COMP. 2ND PARTS.M/RESP.TO STATE
                               ENTRY TH3020
ASSIGN 6 TO 160
GO TO 4
 100.
101.
102.
103.
                                                                  THIS ENTRY COMP. MIXED PARTS.W/RESP.TO STATE AND COSTATE.
                               ENTRY TH3011
ASSIGN 10 TO IGO
GO TO 4
104.
100. - C
100.
                                                                  THIS ENTRY COMP. 1ST PARTS.W/RESP. FO STATE
                              ENTRY TH3010
ASSIGN 20 TO 160
60 TO 4
107.
100.
110. C
111.
112. C
113. C
114. C
116.
116.
117. C
                                                                  THIS ENTRY COMP. 2ND PARTS.W/RESP.TO CONTROL
                              ENTRY TH3002
ASSIGN 30 TO 160
60 TO 5
                             ENTRY TH3001
ASSIGN 40 TO 160
GO TO 5
THIS ENTRY EVAL. THE CONSTRAINING EQ. ONLY
                                                                 THIS ENTRY COMP 1ST PARTS.W/RESP.TO CONTROL
                                                                                                                                                                                                          TH3
TH3
TH3
TH3
TH3
TH3
TH3
120.
123.
                          4 T5 = -DRAGR - DBR+COSA
T6 = LIFTR - DBR+SIMA
                                                                                                                                                                                                          TH3
                                                                                                                                                                                                          TH3
 124.
                        T6 = LIFTR - DBR*51

5 TCDAE = T*CODAE
TSDAE = T*SDAE
OBCA = DB*COSA
DBSA = DB*SIMA
ZZ = -TSDAE + DBSA
YY = -TCDAE + DBCA
T1 = -YY - DRAG
T2 = LIFT - ZZ
T3 = ZZ - DRAGA
T4 = LIFTA - YY
GO TO ISO
                                                                                                                                                                                                          TH3
TH3
TH3
125.
126.
127.
                                                                                                                                                                                                          TH3
TH3
TH3
TH3
TH3
 130.
131.
132.
132.
133.
134.
135.
135.
137.
139.
                                                                                                                                                                                                          TH3
TH3
TH3
TH3
TH3
TH3
TH3
TH3
TH3
                      6 XKIVV = ASF(-DRAGVV, LIFTVV) + DRAGV*2 + LIFTV*2

XKIVV = XKIVV + XKIVV

XKIRV = ASF(-DRAGVR, LIFTVR) - T5*DRAGV + T6*LIFTV

XKIRV = XKIRV + XKIRV

XKIRV = XKIRV + XKIRV

XKIRV = XKIRV + XKIRV

XKIRV = XKIRV + XKIRV

XKIRR = ASF(-DRAGRR - DBRR*COSA, LIFTRR - DBRR*SINA) + T5**2*T6**2

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR

XKIRR = XKIRR + XKIRR
            C
 140.
141.
142.
143.
 144 .
14> .
 140.
                                                                                                                                                                                                          TH3
```

| ORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STOR
BLOCK | AGE
LOC | SUBROUTINE
SUBR CODE | VAI |
|------------------|--|--------------------------|-------------|---|------------|--|--|
| COD | coss _E | I See symbol | · | /DYNA / | (153) | OUTPUT I CO | 0 B
0 D
0 D |
| CODAE | cos(α-6 _É) | 1 See symbol | | /DYNA / | (151) | AL1 CC
AL4 CC
AL7 CC
AL8 CC
AL8 CC
AL9 CC
CONTAL CC
NLDRV CC
NLDRV CC | ODA
ODA
ODA
ODA
ODA
ODA
ODA
ODA |
| COSA | C O S O | I See sy e bol | | /DYNA /4 | (10) | AL4 I CO
AL6 I CO
AL7 I CO
AL8 I CO
AL9 I CO
APPLY I CO
CONTRL I CO
OUTPUT I CO
TH3 I CO | 35A
35A
35A
35A
35A
35A
35A
35A
35A
35A |
| OB ⁻ | D | I [*] Baše drag | (1 | LBS) ⁻ /DYNA ⁻ /4 | 163) | AL1" 08
AL4" 08
AL6 08
AL7 08
AL8 08
AL9 08
ALPLY 08
ALPLY 08
ALDRY 108
ALDRY 10 | 3 |
|) BR | ∂D _b /∂R | I See symbol | | /DVNA /(| 86) | | IR
IR
IR
IR
IR
IR
IR |
|)BRR | ∂ ² D _b /∂R ² | I See symbol | | /DYNA /(| 87) | | RR
RR
RR
RR
RR |
| PAG | | I Aerodynamic dr | eg (L | .BS) /DYWA /(| | AL5 I DR
AL7 I DR
AL8 I DR
AL9 I DR
APPLY I DR
CONTRL I DR
ENVPRO I DR
NLORY I DR
OUTPUT I DR
TH3 I DR
UT M DR | AG AG AG AG |

| FORTRAN
SYMBOL | MATH
Symbol | CODE | DESCRIPTION | ST
BLOCK | LOC | SUBROUT
SUBA C | DE VE |
|-------------------|----------------------------------|--------------|-------------|-------------|---------------------------------------|--|--|
| DRAGA | ∂D/∂ α | 1 See symbol | | /DYNA | /(12) | AL1
AL5
AL7
AL8
AL9
APPLY
TH3 | DRAI
DRAI
DRAI
DRAI
DRAI |
| DRAGAA | 9 ² D/9¢ ² | I See symbol | | /DANW | /(78) | ALI
AL5
AL7
AL8
AL9
APPLY I
TH3 | DRAG
DRAG
DRAG
DRAG
DRAG |
| DRAGR | aD/aR | I See symbol | | /D4#A | /(71) | AL5 I
AL7 I
AL8 I
AL9 I
APPLY I
TH3 I | DRAI
DRAI
DRAI
DRAI |
| DRAGRA | ∂ ² D/∂R∂ α | I See symbol | •• | /DYNA | , , , , , , , , , , , , , , , , , , , | AL1 1
AL5 1
AL7 1
AL8 1
AL9 1
APPLY 1
TH3 1 | DRAI
DRAI
DRAI
DRAI
DRAI |
| DRAGRR | ∂ ² D/∂R ² | 1 See symbol | | /DYNA | | AL5 II
AL7 II
AL8 II
AL9 II
APPLY II
TH3 II | DRA
DRA
DRA
DRA
DRA |
| DRAGV | 9D/8V | 1 See symbol | | /DYNA | | AL5 I
AL7 I
AL8 I
AL9 I
APPLY I
TH3 I | DRA
DRA
DRA
DRA
DRA
DRA |
| DRAGVA | ∂ ² D/∂V∂¤ | l See symbol | | /DYNA | /(75) | AL1 II
AL5 II
AL7 JI
AL8 II
AL9 II
APPLY JI
TH3 JI | DRAI
DRAI
DRAI
DRAI
DRAI |
| DRAGVR | a ² 0/avaR | 1 See symbol | | /DYMA | | AL7 1
AL8 I
AL9 I
APPLY 1
TH3 I | DRAI
DRAI
DRAI
DRAI
DRAI |
| DRAGVV | a ² 0/av ² | l See symbol | | AMPO | /(73) | ALS I
AL7 1
AL8 I
AL9 I
APPLY I
TH3 I | DRAI
DRAI
DRAI
DRAI |

| SYMBOL | MATH
Symbol | CODE | DESCRIPTION | BLOCK | ORAGE
LOC | SUBROUTI
SUBR CO | NE USAG
DE VAR |
|--------|--|------|---|------------|--------------|---|--|
| GMAX | SMAX | 1 | Maximum total acceleration g load | /ARCDA | T/(12) | ALS I
NPLANE I
THROTL I
TH3 I | GMAX
GMAX
GMAX
GMAX |
| GR | 9 _r | 1 | Gravitational acceleration at surface of the earth (FT/SEC* | . /GLOBA | L/(1) | AL5 I
APPLY I
BRAMPT I
COSTAB I
COSTAB I
INTRPT I
OUTPUT I
POBCQL I
PLTOSZ I
SALVE I
SALVE I
TH3 I | GR
GR
GR
GR
GR
GR
GR
GR
GR |
| LIFT | L | I | Aerodynamic lift (LBS |) /DYNA | /(601 | AL4 1 AL5 I AL6 I APLY 1 COMTRL I ENVPRG I OUTPUT 1 TH3 I UT O | LIFT
LIFT
LIFT
LIFT
LIFT
LIFT
LIFT
LIFT |
| LIFTA | ∂ L/∂α | 1 | See symbol | /DYNA
- | /(63)
- | AL1 I
AL4 I
AL5 I
AL6 I
APPLY I
TH3 I
UT O | LIFTA
LIFTA
LIFTA
LIFTA
LIFTA
LIFTA |
| LIFTAA | ∂ ² L/∂a² | 1 | See symbol | /DYNA | /(144) | ALI I
AL4 I
AL5 I
AL6 I
APPLY I
TH3 I
UT O | LIFTA
LIFTA
LIFTA
LIFTA
LIFTA |
| LIFTM | ∂L/∂ m | 1 | See symbol . | /DYNA | /+ 81) | AL4 I
AL5 I
AL6 I
APPLY I
TH3 I
UT 0 | LIFTA
LIFTA
LIFTA
LIFTA
LIFTA |
| LIFTMA | ∂ ² L/∂ m ∂α | 1 | See symbol | /DYNA | /(85) | AL1 I
AL4 I
AL5 I
AL6 I
APPLY I
TH3 I
UT O | LIFTE
LIFTE
LIFTE
LIFTE
LIFTE
LIFTE |
| .IFTMM | ∂ ² L/∂ m ² | I | See symbol | /DYNA | /(84) | AL4 I
AL5 I
AL6 I
APPLY I
TH3 I
UT O | LIFTM
LIFTM
LIFTM
LIFTM
LIFTM |
| LIFTR | 9L/3R | t | See symbol . | /DYNA | /(62) | AL4 I
AL5 I
AL6 I
APPLY I
TH3 I
UT O | LIFTR
LIFTR
LIFTR
LIFTR
LIFTR
LIFTR |

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAL
BLOCK | GE
LOC | SUBRO
SUBR | CODE | USAGE
VAR |
|-------------------|----------------------------------|--------------|-------------|-----------------|-----------|--|----------------------------|--|
| LIFTRA | ∂ ² L/∂R∂œ | l See symbol | | /DYNA /(| | AL1
AL4
AL5
AL6
APPLY
TH3
UT |]
]
]
[| LIFTRA
LIFTRA
LIFTRA
LIFTRA
LIFTRA
LIFTRA
LIFTRA |
| LIFTRM | a²L/aRa∎ | I See symbol | | /DYNA /C | 83) | AL4
AL5
AL6
APPLY
TH3
UT | I
I
I | LIFTRM
LIFTRM
LIFTRM
LIFTRM
LIFTRM
LIFTRM |
| LIFTRR | ∂ ² L/∂R ² | I See symbol | | /DYNA /C | 67) | AL5
AL6
APPLY
TH3
UT | I
I
I
0 | LIFTRR
LIFTRR
LIFTRR
LIFTRR
LIFTRR |
| LIFTV | ∂L/∂¥ | I See symbol | | /DYNA /(| 61) | AL5
AL6
APPLY
TH3
UT | I
I
I
0 | LIFTY
LIFTY
LIFTY
LIFTY
LIFTY |
| LIFTVA | ∂ ² L/∂V∂α | I See symbol | | /DYNA /(| | AL1
AL4
AL5
AL6
APPLY
TH3
UT | - I.
I
I
I | LIFTVA
LIFTVA
LIFTVA
LIFTVA
LIFTVA
LIFTVA |
| LIFTVM | a ² L/aVa∎ | I See symbol | | /DYNA /(| 82) | AL4
AL5
AL6
APPLY
TH3
UT | 1 1 1 | LIFTYM
LIFTYM
LIFTYM
LIFTYM
LIFTYM
LIFTYM |
| LIFTVR | ∂ ² L/∂V∂R
` | 1 See symbol | | /DYNA /(| 65) | AL4
AL5
AL6
APPLY
TH3
UT | I
I
I | LIFTYR
LIFTYR
LIFTYR
LIFTYR
LIFTYR
LIFTYR |
| LIFTVV | a ² L/aV² | 1 See symbol | | /DYNA /(| 64) | AL4
AL5
AL6
APPLY
TH3
UT | 1
1
1
1 | LIFTVV
LIFTVV
LIFTVV
LIFTVV
LIFTVV |
| SID | s i n i E | I See symbol | | /DYMA /(| 154) | DL2
OUTPUT
TH3
UT | | 51D
51D
51D
51D |
| SIDAE | sin(α-ε _E) | 1 See symbol | | /DYNA /(| | AL1
AL4
AL6
AL7
AL8
AL9
APPLY
CONTRL
TH3
UT | I
I
I
I
I
I | SIBAE
SIDAE
SIDAE
SIDAE
SIDAE
SIDAE
SIDAE
SIDAE |

| FORTRAN | HTAM | CODE | DESCRIPTION | | RAGE | SUBROUT | INE USAGE |
|---------|---------------------|-----------------------------------|--|-------|---------|--|--|
| SYMBOL | SYMBOL | | DESCRIPTION | BLOCK | FOC | SUBR C | ODE VAR |
| SINA | s i na | l See symbol | | /DYNA | /(9) | AL4
AL6
AL7
AL8
AL9
APPLY
CONTRL
OUTPUT
TH3 | I SINA I SINA I SINA I SINA I SINA I SINA I SINA I SINA I SINA I SINA I SINA |
| τ | Т | I Thrust | . (LBS) | /DYNA | /(42) | AL4
AL6
AL7
AL8
AL9
APPLY
ARCIN (| M T |
| | bl - | I Weight | (LBS) | /DYNA | /(91) | AL5 I
ENVPRO I
OUTPUT I
POBCOL I
OLTOSZ I
STATEF I
TH3 | #
#
|
| XK1 | | O First entry of
K | 7 3 word in-plane control constraints | /MATS | /(4) | ALGCON I
THROTL I
THI G
TH2 C
TH3 C | : XK1
) XK1
) XK1 |
| XK1MM | K(1) | M The first entr | y in a 3x2 matrix containing K _{ym} | /MATS | /(241) | TH3 F | 1 XK1MM |
| TRIAT | K(1) | | y in a 3x3 matrix containing K _{op} | /MATS | /(124) | TH3 # | XK1MT |
| IK IRR | K (1) | M The first entr | y in a 3x5 matrix containing K _{yh} | /MATS | /(205) | TH2 0 | A XKIRR |
| XKIRT | K(I) | M The first entr | y in a 3x3 matrix containing K _{hp} | /MATS | /(97) | TH3 F | XK1RT |
| XK1T | K ^T 13 | M First entry of
partials of K | 3x3 matrix containing the explicit mith respect to m, K _m | /MATS | /(1) | ALGCON 1
TH1 0
TH2 0
TH3 F | XKIT
XKIT |
| XK1TT | K(1) | O First entry in | 3x6 matrix containing K _{ee} | /MATS | /(23) | ALGCON I | |
| XKJA | ,K _V (1) | A The first entr | y in a 3x8 matrix containing K _y | /MATS | /(46) | ALGCON I
ALGCON I
TH3 F
TH4 0 | / XK7A
XK7A |
| XK I AL | K(1) | M The first entr | y in a 3x3 matrix containing K _{vp} | /MATS | /(70) | ALGCON I | |
| XK J AA | K(1) | M The first entr | y in a 3x8 matrix containing K _{y v} | /MATS | /(142) | ALGCON I
TH3 #
TH4 0 | XK4A |

SUBRØUTINE TH4



This evaluates the airbreather thrust constraint

$$T - T_{AIRB} = 0.$$

In addition, it computes the explicit first and second partials of this constraint with respect to the state and control as they are needed.

```
LOGICAL SMITCH, ILOAD
REAL MACH, ISP, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, ISPW, IFTW, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LIFTWA, LI
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*PV ,PG ,PP ,PR
*POV ,PGG ,PPG ,PRG
*PDR ,POO ,PLG ,PLP
EQUIVALENCE (PAODI,PROD5)
XKIYV = -TARBVH
XKIRV = -TARBHH
XKIV = -TARBHH
XKIV = -TAIRBH
ENTRY TH4002
ENTRY TH4001
IKIT = 1
ENTRY TH4000
XKI = T - TAIRBH
RETURN
END
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| FORTRAN MATH
Symbol Symbol | | | | · | | STORAGE
BLOCK LOC | | SUBROUTINE
SUBR CODE | | | | |
|-------------------------------|------|---|------------|-----------------------|----------------------------|----------------------|-------|-------------------------|------|---|-------------|--|
| | Т | 1 | Thrust | | | (LBS) | /DYNA | | 42) | ALGCON AL1 AL4 AL6 AL7 AL8 AL9 APPLY ARCIM CONTRL DL2 IMPULS OUTPUT TH2 TH3 TH4 | | ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; |
| TAIRB | | 1 | Air-breath | er engine thrust | | (LBS) | /DYNA | /(| 219) | STATEF | 1 | TAIRB |
| TAIRBN | | | Partial of | TAIRB ort b (altitud | la 3 | | /DYNA | /(| 221) | TH4
THA | | TAIRB
Tairbh |
| TAIRBY | | i | | TAIRB art V | | | /DYNA | $\tilde{\kappa}$ | 220) | | | TAIRBY |
| TARBHH | | i | | tial of TAIRB art b | | | /DYNA | 70 | 223) | | | TARBHH |
| TARBUM | | 1 | • | tial of TAIRB art V a | nd h | | /DYNA | 70 | 224) | | | TARBVH |
| TARBVV | | 1 | • | tial of TAIRB prt V | | | /DYNA | /(| 222) | | | TARBVV |
|
XK1 | • • | 0 | • | y of 3 word in-plane | control constra | ints | /MATS | | 4.) | | I
0
0 | XK1
XK1
XK1
XK1
XK1
XK1 |
| XKIAR | K(1) | 0 | The first | entry in a 3x5 matrix | containing K _{yh} | ì | /MATS | /(| | TH2
TH3
TH4 | 0 | XKIRA
XKIRA
XKIRA |
| XK1A | K(1) | | The first | entry in a 3x8 matrix | containing K _y | | /MATS | /(| | ALGCON
ALGCON
TH3
TH4 | I | KK 1 V
KK 1 V
KK 1 V |
| XKIAA | K(1) | 0 | The first | entry in a 3x8 matrix | containing Kyv | | /MATS | /(| | ALGCON
TH3
TH4 | M | KK 1 A A
KK 1 A A
KK A A |

6 OCT 72 6.01-44

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SUBRØUTINE TRAJIN



TRAJIN takes care of setting various flags and paramters at the initial point of the trajectory.

```
SUBROUTINE TRAJIN

COMMON /CATRL/
*NU ITER ITAPA ITAPB JMIN JMAX LINES KPT MOM
*KARD INDX(4) NEWNOM CATOLO RHOC RHOP MPTS MINES
*KPAGE NNP MUP IARC TRSTR IMAX KTIME KONVER NOPRNT,
*INBORY NUPAGE IVARY(20) NN NOVARY PLAST ZLAST,
*COMMON/GLOBAL/
*GR ER OMGZ KLAMRF, YMURF LUM TO EPSLON, INNER
*ITAMAX JJUP(6) IFATAL NARC NBRAN NFARC ID(4) KTAB(20),
*ITAMAX JJUP(6) IFATAL NARC NBRAN NFARC ID(4) KTAB(20),
*INTAMEZO), SIG MAXTAB GM PSIÄF IPFLGI IPFLG2, IPFLG3, IPFLG4,
*INTAMEZO) SIG MAXTAB GM PSIÄF IPFLGI IPFLG2, IPFLG3, IPFLG4,
*INTAMEZO) SIG MAXTAB GM PSIÄF IPFLGI IPFLG2, IPFLG3, IPFLG4,
*INTAMEZO) SIG MAXTAB GM PSIÄF IPFLGI IPFLG2, IPFLG3, IPFLG4,
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*INTAMEZO) SIG MAXTAB GM PSIÄF IPFLGI IPFLG2, IPFLG3, IPFLG4,
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*INTAMEZO) SIG MAXTAB GM PSIÄFT IPFLG3, IPFLG4,
*INTAMEZO) SIG MAXTAB GM PSIÄFT IPFLG1 IPFLG3, IPFLG4,
*INTAMEZO) SIG MAXTAB GM PSIÄFT IPFLG1 IPFLG3, IPFLG4,
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TRAJIN
TRAJIN
54.
55.
56.
57.
58.
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END
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TRAJIM

TRAJIN CNTRL CNTRL CNTRL CNTRL CNTRL CNTRL GLOBAL GLOBAL



| FORTRAM
SYMBOL | MATH
SYMBOL | CODE | DESCRIPTION |) N | BLOCK | LOC | SUBROUTII
SUBR COI | E VAR |
|-------------------|----------------|------------------------------|------------------------|-----------------------|-----------|------|--|--|
| ALPHA | a | O Angle of atta | re t | (RAD) | /DYNA /(| 79) | AEROCO I
ALGGOM MALZ I
ARCIN M
COMTAL M
COMTAL M
COMTAL M
CONTAL M
INPLANE I
OUTPUT I
TRAJIN O
UT UT I
WRAPUP I | ALPHA
ALPHA
ALPHA
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ALPHA
ALPHA |
| DELTAE | *E | O Engine defiec | tion . | (RADS) | /DYMA /(| 155) | ALGCON R
ARCIN R
CONTRL M
DL1 I
DUTPUT I
TRAJIN O
UT I | DELTAI
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DELTAI |
| IPRNT | | D Not used. | | | /CMTRL /I | 29) | DUTPUT R
SALVE O
TRAJIM O | NOPRNI
NOPRNI
I PRNI |
| OMEGA | • | M Earth rotatio | n rate | (RAD/SEC) | /DYNA /(| 5) | AL4 I
AL7 I
COMTRL I
PDBCQL I
TRAJIN M | OMEGA
OMEGA
OMEGA
OMEGA |
| OMEGAT | 2 | O See symbol | · | · • • | /DYMA /(| 12) | NLDRV 1
TRAJIN 0 | OREGAT |
| ome gaz | ay 2 | O See symbol | | | /BYNA /(| 63 | AL4 I
AL7 I
AL8 I
AL9 I
NLORV I
TRAJIN O | OMEGAZ
OMEGAZ
OMEGAZ
OMEGAZ
OMEGAZ |
| OMGZ | • | I Earth rotation | n rate | (RAD/SEC) | /GLOBAL/(| 3) | PDBCQL I | OMGZ
OMGZ |
| TSTAGE | | O Trajectory til
Ignited. | ne at which present r | cket engine
(SECS) | /DYNA /(| 167) | ARCIN M
STATEF I
TRAJIN O | TSTAGE
TSTAGE
TSTAGE |
| TSTART | | O Trajectory th | me at which present so | ibert commenced. | /DYNA /(| 141) | ARCEN M
ARCIN M
STATEF I
TRAJIN O | TSTART
TSTART
TSTART
TSTART |
| ro | ^t o | 1 Trajectory st | ort time. | (SEC) | /GLOBAL/(| 7) | FETCH A
INARC M
TRAJIM I
WRAPUP I | TO
TO
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SUBRØUT I NE UT



UT computes all those dynamic quantities that bear an explicit dependence on the in-plane control.

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                                                                       THIS ENTRY COMPUTES ALL THOSE CONTROL-DEPENDENT
QUANTITIES THAT ARE NEEDED TO CONVERGE THE IN-PLANE
CONTROL WHEN THE ANGLE OF ATTACK IS TO BE OPTIMAL
104.
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111.
112.
113.
114.
115.
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                                 ENTRY UTOP
ASSIGN 105 TO LABL3
ASSIGN 108 TO LABL4
ASSIGN 1062 TO LABL5
GO TO 100
                                                                                                                                                                                                                         UT
UT
                                                                                                                                                                                                                         ŭΤ
                                                                                                                                                                                                                                              100-
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                                                                       THIS ENTRY COMPUTES ALL THOSE CONTROL-DEPENDENT DUANTITIES THAT ARE NEEDED TO CONVERGE THE IN-PLANE CONTROL WHEN THE ANGLE OF ATTACK IS TO BE NON-OPTIMAL
                                                                                                                                                                                                                         ŭΫ
                                                                                                                                                                                                                         TU
TU
TU
                                ENTRY UTNOP
ASSIGN 106 TO LABL3
ASSIGN 109 TO LABL4
ASSIGN 1063 TO LABL5
                                                                                                                                                                                                                         ũŤ
                    ASSIGN 1063 TO LABLS

100 SINA = SIN(ALPHA)
COSA = COS(ALPHA)
SID = SIN(DELTAE)
COD = COS(DELTAE)
SIDAE = SINA*COD - COSA*SID
CODAE = COSA*COD + SINA*SID
10, IF(.NOT.ILOAD) RETURN
CALL AEROCO
OS = Q**SREF
GO TO LABL3

10.0 PM = Q**MACHY
119.
120.
121.
122.
                                                                                                                                                                                                                         UT
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105 ULFTAR = QS*CLAR
DRAGAR = QS*CDAR
106 ULFTA = QS*CLA
DRAGA = QS*CDA
ULFT = QS*CD
DRAG = QS*CD
IF(JAER .EQ. 3) SO TO 107
SO TO LABL5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              152.
153.
                     194.
196.
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162.
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                                                                                                                                                                      GO TO LABLS

10-1 LIFTWY E ULFTVY
LIFTWR E ULFTVR
LIFTWR = ULFTRR
LIFTWR = ULFTRR
LIFTWR = ULFTRR
LIFTWR = ULFTV
LIFTWR = ULFTV
LIFTWR = ULFTV
10-2 LIFTWR = ULFTWR
RETURN
                         189 :
                                                                                                                                                                          1043 LIFTA = ULFTA
1043 LIFT = ULFT
RETURN

107 CALL REDRECO
GSD = QSSDRF
LCD = ULFT*COSA + DRAG*SIMA
LSD = ULFT*SIMA - DRAG*COSA
LSD = ULFT*SIMA - DRAG*COSA
LSD = ULFT*SIMA - DRAG*COSA
LSD = ULFTA*SIMA - DRAG*COSA
LSD = ULFTA*SIMA - DRAG*COSA
IF = XCG - XCGR
VF = ZCG - ZCGR
VF = ZCG - ZCGR
VF = ZF - ZCG
WF = XT - XCG
FACTON = XJ/WF
LCDAM = LSDA + LSD
LSDAM = LSDA + LSD
LSDAM = LSDA + LSD
LSDAM = LSDA + LSD
LSDAM = LSDA + LSD
LSDAM = LSDA + LSD
LSDAM = LSDA + LSD
LSDAM = LSDAM + LSD
LSDAM = LSDAM + LSD
LSDAM = LSDAM + LSD
LSDAM = LSDAM + LSD
LSDAM = LSDAM + LSD
LSDAM = SIMA*ULFTY + SIMA*DRAGAW
LSDY = SIMA*ULFTY + SIMA*DRAGAW
LSDY = SIMA*ULFTY + SIMA*DRAGAW
LCDVM = COSA*ULFTA + SIMA*DRAGAW
LCDVM = COSA*ULFTA + SIMA*DRAGAW
LCDVM = COSA*ULFTA + SIMA*DRAGAW
LCDVM = COSA*ULFTA + SIMA*DRAGAW
LCDVM = COSA*ULFTA + SIMA*DRAGAW
LCDVM = COSA*ULFTA + SIMA*DRAGAW
LCDVM = COSA*ULFTA + SIMA*DRAGAW
LCDVM = COSA*ULFTA + SIMA*DRAGAW
LSDAM = SIMA*ULFTYM - COSA*DRAGAW
LSDAM = SIMA*ULFTAM - COSA*DRAGAW
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LSDAM = SIMA*ULFTAM - COSA*DRAGAW
LSDAM = SIMA*ULFTAM - COSA*DRAGAW
LSDAM = SIMA*ULFTAM - COSA*DR
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            170.
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            172.
                 1/4.
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```

| FORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | | BLOC | ORAG
K | F CC | SUBROUT
SUBA (| INE US | AGE |
|-------------------|--|----------------------------|---------|--------|-----------|------|--|----------------------------------|----------------------------------|
| ALPHA | α | I Angle of attack | (RAD) | /DYNA | /(| 79} | ENVPRO
MOMECO
NPLANE
OUTPUT
TRAJIN
UT | | HA
HA
HA
HA
HA
HA |
| CD | c ^D | 1 Drag coefficient | | /DYNA | /(| 192) | AEROCO
OUTPUT
UT | 0 CD | |
| CDA | C _{De} | I Drag coefficient slope | (RAD-1) | /DYNA | 11 | 193) | AEROCO | | |
| CDAA | 9C ^D /9¤ | 1 See symbol | | /DYNA | /(| 1951 | AEROCO
UT | M CDA | |
| CDAM | ac _{D•} ∕aw | 1 See symbol | | /DYNA | /(| _ | UT | M CDAI | |
| CDM | ac _D /am | I See symbol | | /DYNA | /(| | | I COM |) |
| CDMM | a ² C _D /am ² | I See symbol | | /BYNA | /(| | _ | I CDM | |
| CL | c ^r . | I " Lift coefficient" " | | /DYNA | /(| 186) | AEROĆO
OUTPUT
UT | | |
| CLA | c _{Le} | I Lift coefficient slope | (RAD-1) | /DYNA | /(| 187) | AEROCO
Statef
Ut | M CLA | |
| CLAA | 96_49@ | I See symbol | | /DYNA | /(| 189) | AEROCO
UT | | A |
| CLAM | ac <mark>r"</mark> /aw | I See symbol | | /DYNA | /(| 191) | AEROCO
Statef
Ut | | A |
| CLM | ac ^r /aw | I See symbol | | /DYNA. | /(| 188) | AEROCO
Ut | M CLM | |
| CLAM | a ² C _L /am² | 1 See symbol | | /DYNA | /(| 190) | AEROCO
UT | M CLAW | |
| CM | C, | I Moment coefficient | | /DYNA | /(| | | i em | |
| CMA | C. | I Moment coefficient slape | (RAD-1) | /DYMA | /(| | UT | M CMA
I CMA | |
| CMAA | ∂C ₂₂ /∂α | I See symbol | | /DYNA | /(| | | I CMAP | |
| CMAM | ac _{ee} /am | I See symbol | | /DYNA | /(| | | I CMAP
M CMAP
I CMAP | A |
| CMA | 9C_/9M | 1 See symbol | | /DYNA | /(| 124) | MOMECO I | O CAM
I CAM | |
| CMMM | ∂ ² C _m /∂M ² | J See symbol | | /DYNA | K | | MOMECO I | O CMMP
I CMMP | |
| 000 | cos6 _E | R See symbol . | | /DYNA | /(| | OUTPUT
TH3 | I COD
I COD
I COD
M COD | |

| FORTRAM
Symbol | MATH
Symbol | CODE | DESCRIPTION | <u>\$1</u>
Bloc | ORAS | LOC | SUBROUTI
SUBR CO | NE USAGE
DE VAR |
|-------------------|--|------------------|-------------|--------------------|------|------|---|--|
| | | | | | | | | |
| CODAE | cos(α-δ _E) | O See symbol | | /DYNA | /(| 151) | AL1 I
AL4 I
AL6 I
AL7 I
AL8 I
AL9 I
APPLY I
CONTRL I
NLDRY I
TLDRY I
UT O | CODAE
CODAE
CODAE
CODAE
CODAE
CODAE
CODAE
CODAE
CODAE
CODAE |
| COSA . | c o s α | M See symbol | | / DY MA | /(| 10) | ALI I AL4 II AL6 II AL8 II AL8 II AL9 II APPLY I CONTRE II NEDRY I OUTPUT I THIS IUT M | COSA
COSA
COSA
COSA
COSA
COSA
COSA
COSA |
| - | D, | I Base dreg | | /DYNA | /(| 163) | AL1 I
AL4 I
AL6 I
AL7 I
AL8 I
AL9 I
AL9 I
AL9 I
ALDRY I
OUTPUT I
STATEF I
THA I
I | 08
08
08
08
08
08
08
08
08
08 |
| OBR | aD _b ∕aR | I See symbol | | /DYNA | /(| 86) | AL1 I
AL4 I
AL6 I
AL7 I
AL8 I
AL9 I
APPLY I
STATEF I
TH3 I
UT I | DBR
DBR
DBR
DBR
DBR
DBR
DBR
DBR
DBR
DBR |
| DBRR | ∂ ² D _b /∂R ² | 1 See symbol | | /DYNA | /(| 87) | AL4 I
AL6 I
AL7 I
AL8 I
AL9 I
APPLY I
STATEF I
TH3 I
UT I | DBRR
DBRR
DBRR
DBRR
DBRR
DBRR
DBRR
DBRR |
| DELTAE | · E | I Engine deflect | ion (RADS) | /DYNA | /(| | ALGCON A
ARCIN M
CONTRL M
DL1 I
OUTPUT 1
TRAJIN O
UT I | DELTAE
DELTAE
DELTAE
DELTAE
DELTAE
DELTAE |

| FORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | <u>Storage</u> <u>Subroutine u</u>
Block loc Subr Code |
|-------------------|----------------------------------|--------------------|---|
| DRAG | D | M Aerodynamic drog | (LBS) /DYNA /(69) ALS I DR
AL7 I DR
AL8 I DR
AL9 I DR
APPLY I DR
COMTRL I DR
ENVRRD I DR
HLORY I DR
OUTPUT I DR
TH3 I DR
UT M DR |
| DRAGA | ∂D/∂ α | M Sae symbol | /DYNA /(72) AL1 I DR AL5 I DR AL7 I DR AL8 I DR AL9 I DR APPLY I DR TH3 I DR UT M OR |
| DRAGAA | ∂ ² D/∂œ ² | fi See symbol | /DYNA /(78) AL1 I DR/
AL5 I DR/
AL7 I OR/
AL8 I DR/
AL9 I DR/
APPLY I DR/
TH3 I DR/
UT M DR/ |
| DRAGR | ∂D√∂R | · M See symbol | -/DYNA /(71) AL5 I DRI
AL7 I DRI
AL8 I DRI
AL9 I DRI
APPLY I DRI
TH3 I DRI
UT M DRI |
| ORAGRA | ∂ ² D/∂R∂œ | M See symbol | /DYNA /(77) ALI I DR
AL5 I DR
AL7 I DR
AL8 I DR
AL9 I DR
APPLY I DR
TM3 I DR
UT M DR |
| DR A GRR | ∂ ² D/∂R² | F See symbol | /DYNA /(76) AL5 I DR:
AL7 I DR
AL8 I DR:
AL9 I DR:
APPLY I DR:
TH3 I DR:
UT M DR: |
| DRAGV | 9D/9V | A Sea symbol | /DYMA /(703 AL5 I DR/
AL7 I DR/
AL8 I DR/
AL9 I DR/
APPLY I DR/
TH3 I DR/
UT # DR/
UT # DR/ |
| DR A G V A | ∂ ² D/∂V∂¤ | A See sy≡bei | /DYNA /(75) ALI I -DR/ AL5 I DR/ AL7 I DR/ AL8 I DR/ AL9 I DR/ AL9 I DR/ APPLY I DR/ TH3 I DR/ UT M DR/ |

:



| FORTRAN
Symbol | MATH
Symbol | COD | DESCRIPTION | | BLOC | ORA) | LOC | SUBROL
SUBR | COD | E USAGE
E VAR |
|-------------------|--|-----|--|-------|----------|---------|-------|--|-----------------------|--|
| DRAGVA | a ² D∕avaR | • | See symbol | | /DYNA | /(| 74) | ALS
AL7
AL8
AL9
APPLY
TH3
UT | I
I
I
I | DRAGVR
DRAGVR
DRAGVR
DRAGVR
DRAGVR
DRAGVR |
| DRAGVV | a²□/av²
- | A | See symbol | | /DYNA | /(| 73) | AL5
AL7
AL8
AL9
APPLY
TH3
UT | I
I
I
I | DRAGY V
DRAGY V
DRAGY V
DRAGY V
DRAGY V
DRAGY V |
| DREF | Dref | 1 | Aerodynamic reference length | | / AR CBA | 1/(| 371 | STATEF | t
I | DREF
DREF |
| ILOAD | | 1 | Logical fing that is true if there is any serodynamic lead on the vehicle. | | /DYNA | /(| 181) | ARCIN
CONTRL
NPLANE
UT | A | ILOAD
ILOAD
ILGAB
ILOAD |
| JAER | | I | Aerodynamic model option flag | | /ARCDA | T/(| 9) | AEROCO
ARCIN
DUTPUT
STATEF
UT | 1 | JAER
JAER
JAER
JAER
JAER |
| UFT _ | ٤ | 0 | Aarodyngaic lift | (LBS) | ./DYNA | /(| _ 60) | AL4 AL5 AL6 APPLY COMTRL ENVPRO OUTPUT TH3 UT | 1 | LIFT
LIFT
LIFT
LIFT
LIFT
LIFT
LIFT
LIFT |
| LIFTA | ∂L/∂ α | 0 | Sae symbol | | /DYNA | /(| 63) | AL1
AL4
AL5
AL6
APPLY
TH3
UT | I
I
I
I
I | LIFTA
LIFTA
LIFTA
LIFTA
LIFTA
LIFTA |
| LIFTAA | ∂ ² L/∂α ² | Q | See syabei | | /OYNA | /(| 144) | ALI
AL4
AL5
AL6
APPLY
TH3 | I
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I
I | LIFTAA
LIFTAA
LIFTAA
LIFTAA
LIFTAA
LIFTAA |
| LIFTM | ∂L/∂∎ | 0 | See symbol | | /DYMA | /(| 81) | AL4
AL5
AL6
APPLY
TH3
UT | i | LIFTM
LIFTM
LIFTM
LIFTM
LIFTM
LIFTM |
| LIFTMA | ∂ ² L/∂∎∂¢ | 0 | See symbol | | /DYNA | /(| 85) | AL1
AL4
AL5
AL6
APPLY
TH3
UT | i
I
I | LIFTMA
LIFTMA
LIFTMA
LIFTMA
LIFTMA
LIFTMA
LIFTMA |
| LIFTMM | ∂ ² L/∂ m ² | a | See symbol | | /DYNA | /(
_ | 84) | AL4
AL5
AL6
APPLY
TH3
UT | !
!
!
! | LIFTMM
LIFTMM
LIFTMM
LIFTMM
LIFTMM
LIFTMM |



| ORTRAN
Symbol | MATH
Symbol | CODE | | DESCRIPTION | <u>\$1</u>
8LOC | ORAGE
K LOC | SUBROUT
SUBA C | INE USAGE
ODE VAR |
|------------------|----------------------------------|-------|----------|-------------|--------------------|----------------|--|--|
| LIFTR | aL/a R | 0 500 | symbol | | /DYNA | /(62) | AL5
AL6
APPLY
TH3 | LIFTR LIFTR LIFTR LIFTR LIFTR LIFTR |
| LIFTRA | ∂ ² L/∂R∂α | 0 500 | symbol | | /DYNA | /(48) | AL1
AL4
AL5
AL6
APPLY | LIFTRA
LIFTRA
LIFTRA
LIFTRA
LIFTRA
LIFTRA |
| LIFTRA | ∂ ² L/∂R∂ ∍ | 0 500 | symbol | | / DY NA | /(83) | ALS
AL6
APPLY
TH3 | LIFTRA
LIFTRA |
| LIFTRR | 92F\985 | O See | symbol | | /DYNA | /(67) | AL5 I
AL6 I
APPLY | LIFTRE
LIFTRE
LIFTRE
LIFTRE |
| LIFTY | 9୮/9۸ | 0 See | symbol - | | /DYMA | /(61) | AL4 1
AL5 1
AL6 1
APPLY 1
TH3 1 | LIFTY.
LIFTY
LIFTY
LIFTY |
| LIFTVA | ∂ ² L/∂V∂ α | 0 500 | symbol | | /DYNA | /(66) | AL1 1
AL4 1
AL5 1
AL6 1
APPLY 1
TH3 1 | LIFTVA
LIFTVA
LIFTVA
LIFTVA |
| .IFTVM | a ² ∟/avam | 0 500 | symbol | | /DYMA | /(82) | AL4 I
AL5 I
AL6 I
APPLY I
TH3 I
UT (| LIFTYM
LIFTYM
LIFTYM |
| .]FTVR | a ² l/avar | O See | symbol | | /DYNA | /(65) | AL4 I
AL5 I
AL6 I
APPLY I
TN3 I
UT C | LIFT VE
LIFT VE
LIFT VE
LIFT VE |
| .IFTVV | a ² L/av ² | 0 5** | symbol | | /DYMA | /(64) | | LIFTAN
LIFTAN
LIFTAN
LIFTAN |
| ACHR | am/ar | I See | symbol | | /DYMA | /(44) | STATEF # | MACHR |
| ACHRR | ∂ ² m/∂R ² | I See | symbol | | /DYNA | /(118) | STATEF P | MACHER |
| ACHV | 3M/3V | 1 500 | symbol | | /DYNA | /(43) | STATEF # | |
| ACHVR | ∂ ² m/∂v∂R | I See | syebe i | | /DYNA | | STATEF O | |

| | FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | | STORA
BLOCK | LOC | SUBROUT
SUBR | INE USAGI |
|-----|-------------------|--|----------|----------------------------|------------------------|----------------|------|---|---|
| | 9 | 9 | 1 | Dynamic pressure | (LBS/FT ²) | /DYMA /(| 27) | ENVPRO
OUTPUT
PDBCQL
STATEF
UT | 1 0 |
| | OR | AG/bB | 1 | See symbol | | /DYMA /(| 29) | PDBCQL
STATEF
UT | |
| | ORR | ∂ ² q/∂R ² | 1 | See symbol | | /DYNA /C | 32) | STATEF | M QAR
I QRR |
| | 0 V | V6 \p6 | I | See symbol | | /DYNA /(| 28) | PDBCOL
STATEF
UT | |
| | OVR | ∂ ² q/∂V∂R | 1 | See symbol | | /DYNA /C | 31) | STATEF | M QVR
I QVR |
| | 044 | 92d/9A5 | 1 | See symbol | | /DYNA /C | 30) | STATEF | |
| | Sto | s i n i E | A | See symbol | | /DYNA /(| 154) | DL2
GUTPUT | 1 S1D |
| | SIDAE | sîn(α-6 _E) | . | See symbol | | /DYNA /(| 152) | - | I SIDAE
I SIDAE
I SIDAE
I SIDAE
I SIDAE |
| | | | | <i>.</i> ` | | | | AL9
APPLY
CONTRL
TH3 | I SIDAE
I SIDAE
I SIDAE
I SIDAE
O SIDAE |
| | 51 MA | s i nα | • | See symbol | | /DYNA /(| 9) | AL4
AL6
AL7
AL8
AL9
APPLY
CONTRL
OUTPUT
TH3 | |
| | SREF | S _{ref} | I | Aerodynamic reference area | (FT ²) | /ARCDAT/(| 1) | BNDRY
CHECK
FETCH
SALVE
STATEF | I SREF
I ARCDA
I ARCDA
I ARCDA
I ARCDA
I SREF
I SREF
I ARCDA |
| | ULFT | L | A | Untrinned serodynamic lift | (LBS) | /OYMA /(| 164) | KPLANE | I ULFT
I ULFT
M ULFT |
| | ULFTA | ∂L _u /∂∝ | A | See symbol | | /DYMA /C | 166) | | I ULFTA |
| | ULFTAA | ∂²L ₄ /∂α² | M | See symbol | | /DYNA /C | 178) | | I ULFTAA
M ULFTAA |
| | ULFTR | aL _u /aR | M | See symbol | | /DYNA /(| 133) | | 1 ULFTR |
| | ULFTRA | ∂ ² L _u /∂R∂α | A | See symbol | | /DYNA /(| 138) | AL3 | I ULFTRA
M ULFTRA |
| | ULFTAR | ∂ ² L _m /∂R ² | M | See symbol . | | /DYMA /(| 137) | AL3 | I ULFTRE |
| • • | ULFTV | 9L"/8V | n | See symbol | | /DYNA /C | 132) | | 1 ULFTY |

•

| ORTRAM
Symbol | MATH
Symbol | COD | • DESCRIPTION | | BLOCK | DRAG | LOC | SUBROU
SUBR | COD | E USAGE
E VAR |
|------------------|---|-----|--|-----|----------|------|-------|--|------------------|-------------------------|
| ···· | 311100 | | | | 82001 | ` | | | - | |
| ILFTVA | ∂ ² L_/∂V∂œ | M | See symbol | | /DYNA | /(| 136) | AL3
UT | I
B | ULFTVA |
| ILFTVR | ∂ ² L_/∂V∂R | M | See symbol | | /DYNA | H | 135) | - | I | ULFTVR |
| ILFTVV | a ² L ₄ /av ² | M | See symbol | | /DYNA | /(| 134) | • - | I | ULFTVV |
| CE | Xce | 1 | Center of gravity body z station (| FT) | /DYNA | /(| 157-) | DL2
STATEF
UT | I
I | xce
xce
xce |
| CGA | 9x _{CG} /3m | I | See symbol | | /DYNA | /(| 108) | DL2
STATEF
UT | I
M
I | XCGM
XCGM |
| CGAA | ⁹² X _{cc} /∂ m² | 1 | See symbol | | /DYNA | /(| 109) | DL2
STATEF
UT | I
M
I | XCGMM
XCGMM
XCGMM |
| CGR | XCGR | 1 | Reference mcg location | FT) | / AR CDA | 7/6 | 32) | UT | 3 | XCGR |
| ı | j | t | Control blend factor | | /DYNA | /(| 159) | ARCIN
DL2
OUTPUT
STATEF
UT | O
I
I
I | X)
X)
X)
X) |
| JR | aj/aR | 1 | See symbol | | /DYNA | /ŧ | 113) | STATEF | | XJR
XJR
XJR |
| JRR | a²j/aR² | 1 | See symbol | | /DYNA | 11 | 116) | | 1
0
1 | ARLX
ARLX
ARLX |
| JV | aj/av | 1 | See symbol | | /DYNA | /(| 112) | DL2
STATEF
UT | I
0
1 | XTA
XTA
XTA |
| JVR | a²j/ava¤ | 1 | See symbol | | /DYNA | /€ | 115) | DL2
Statef
Ut | 1
0
1 | TJVR
RVLX
RVLX |
| JVV | a ² j/av² | 1 | See symbol | | / DYNA | /(| 114) | DL2
STATEF
UT | 1
0
1 | XJAA
XJAA
XJAA |
| MC6 | H _{CE} | Ħ | Aerodynamic moment about center of gravity (FT-L | BS) | /DYNA | /(| 160) | BL2
OUTPUT
UT | I | XMC6
XMC6 |
| MCGA | ∂M _{CG} /∂ a | M | See symbol | | VDANU | /(| 176) | DL2
UT | I | XMCGA
XMCGA |
| MCGAA | ∂ ² M _{C6} /∂ a ² | Ħ | See symbol | | /DYNA | /(| 169) | DL2
UT | I | XMCGAA
XMCGAA |
| MCGM | ∂M _{CG} /∂= | Ħ | See symbol | | /DYNA | /(| 203) | DL2
UT | H | MODRI |
| MCGMA | ∂ ² M _{CG} /∂≡∂α | R | See symbol | | /DYNA | /(| 212) | DL2
UT | I | XMCGMA |
| REGMA | 8 ² M _{CG} /8n ² | A | See symbol | | /DYNA | /(| 211) | DL2
UT | I | XMCGMM
XMCGMM |
| MCGR | ∂M _{CG} /∂R | Ħ | See symbol | | /DYNA | /(| 202) | UT | N
I | incgr
incgr |
| MCGRA | ∂ ² M _{CG} /∂R∂¤ | n | See symbol | | /DYNA | /(| 210) | uT | I | XMCGRA
XMCGRA |
| MCGRM | ∂ ² M _{CG} /∂R∂∎ | M | See symbol | | /DYNA | /(| 209) | IJŦ | H | IMCGRM
IMCGRM |
| MCGRR | ∂ ² M _{CG} /∂α ² | m | See symbol | | /DYMA | /(| 208) | UT | ī | XMCGRR
XMCGRR |
| ACGV | ∂M _{CG} /∂V | A | See symbol | | /DYNA | /(| 201) | DL2
UT | I | XMCGV |

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | | BLOC | ORAG | LOC | SUBROU
SUBR | | USAGE
VAR |
|-------------------|---|------|---|------|----------|------|------|---------------------|-------------|-------------------------|
| AVGORX | ∂ ² M _{CG} /∂V∂∝ | n | See ayabol | | /BYNA | /(| 207) | DL2
UT | ĭ | XMCGVA |
| XMCGVM | ∂ ² M _{CG} /∂V∂∎ | M | See symbol | | /DYNA | /(| 206) | DL2
UT | i | XMCGVM |
| XMCGVR | ∂²M _{CG} /∂v∂R | M | See symbol | | /DYNA | /(| 205) | DL2
UT | î
A | XMCGVR
XMCGVR |
| XMCGVV | a ² M _{CG} /av ² | M | See symbol | | /DYNA | /(| 204) | DL2
UT | J | XMCGVV |
| TX | x _T | 1 | Aerodynamic trim surface body x station | | / AR CDA | 7/6 | 36) | UT | ı | XT |
| ZCG | z _{ce} | I | Center of gravity body z station | (FT) | / DYNA | /(| 158) | DL2
STATEF
UT | 1 | 106
106
106 |
| ZCGM | 9I ^{CC} /9m | ī | See symbol | | /DYNA | /(| 110) | DLZ
STATEF
UT | I
A
I | ZCGM
ZCGM
ZCGM |
| ZCGMM | 92Z _{C6} /9#2 | 1 | See symbol | | /DYNA | /(| 111) | DL2
STATEF
UT | 1
A
1 | ZCGMM
ZCGMM
ZCGMM |
| ZCGR | Z _{CGR} | 1 | Reference zcg location | (FT) | / AR CDA | T/(| 33) | UT | 1 | ZCGR |
| ZE | Z _E | 1 | Engine thrust centroid body z station | | / ARCBA | 7/(| 35) | BL2
UT | I
I | ZE
ZE |

SUBRØUT I NE WRAPUP

Purpose

WRAPUP controls the integration of the converged QL solution. It also writes that solution or logical unit 11 for the possible use later as a starting guess for steepest descent or QL itself. Finally, WRAPUP controls the QL trajectory to sizing interface.

```
1.
2.
3.
4.
                                                               PROGRAM WRAPUP
                                                                                                                                        THIS ROUTINE CONTROLS THE INTEGRATION OF THE CON-
VERGED QL SOLUTION. IT ALSO WRITES THAT SOLUTION
ON UNIT 11 FOR THE POSSIBLE USE LATER AS A STARTING
SOLUTION FOR STEEP. DESC. OR QL ITSELF. FINALLY,
THIS ROUTINE CONTROLS THE QL TRAJ. TO SIZING INTER-
FACE.
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    13.
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                                                       -XLMAX
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64.
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                                                                   WRITE CONVERGENCE NOTE
                                                                                                                                                                                                                                                                                                                                                                                                                                  JUL21
JUL21
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JUL21
                                                   " 'WRITE(6, '1) - - "
                                                                   COMBINE UP THE LAST NOMINAL.
                                                                L = 1 - N

ADM = 0

DD 70 IARC = 1, NARC

L = L + N

MOM = NOC(IARC)

NN = N<(MOM + 1)

CALL RAEADMS(41, S, NN, 2*IARC - 1)

CALL RATALT(Y(L), S(N + 1), C, N, MOM, 1)

CALL MATADDS(Y(L), Y(L), S, N, 1)

IF(IARC - 1) 50, 50, 60

CY(IARC) = Y(L + 7) + TO
                                                                                                                                                                                                                                                                                                                                                                                                                                 JUL21
JUL21
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      111.
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JUL21
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 120.
121.
                                                  50 QT(1ARC) = Y(L + 7) + TO
GO TO 70
                                                                                                                                                                                                                                                                                                                                                                                                                                  JUL21
JUL21
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          70-
 122.
                                                  60 QT(IARC) = Y(L + 7) + QT(IARC - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                  JUL 21
                                                  70 CONTINUE
REWIND INARK
NS = N/2 - 1
WRITE(INARK) TO,
                                                                                                                                                                                                                                                                                                                                                                                                                                 JUL21
JUL21
JUL21
    123.
   124.
125.
                                                              WRITE([NARK) TO, NS, NARC, (QT([K], [K = 1, NARC), (ZERO([K], [K = +1, NARC), (ZERO([K), [K = 1, NARC), (ZERO([K), [K = 1, NARC)
                                                                                                                                                                                                                                                                                                                                                                                                                               JUL21
JUL21
JUL21
JUL21
JUL21
JUL21
 126 .
127 . C
                                                  DO 71 I = 1,50
71 Z(I) = 0.
NN = N + MAUX
CALL GINTRI
L = -N
KODES = -1
IDAM = 1
 128.
129.
130.
131.
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126.
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JUL21
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                                 CCC
                                                                                                                                                                                                                                                                                                                                                                                                                                  101 21
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JUL21
                                                                   START THE INTEGRATION.
                                                 81 DO 13 JARC = 1, NARC
                                                                  STORE FIRST POINT OF SUBARC IN Z-ARRAY.
                                                        L = L + M
00 9 I = 1, M
J = L + I
9 Z(I) = Y(J)
   143.
144.
145.
170.
                                                                  STORE INITIAL POINT OF SUBARC.
```

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150. TI = IARC

151. C

1>2. C

1>3. C

1>4. C

1>5. C

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                                                                                                TI = IARC - 1
                                                                                                COMPUTE FINAL POINT OF SUBARC.
                                                                                                READ IN THE DATA FOR THIS SUBARC.
                                                                                                CALL READMS(9, ARCDA, 42, IARC)
COMPUTE STEPSIZE.
                                                                                              DY = DTNC/Z(IDP)
NPTS = 1000000
NEWNOM = TRUE.
TY = TI
TP = TI
KPT = 0
                                                             JUL21
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    168.
    1f9:
172.
  1/3.
1/4.
1/5.
1/6.
1/6.
1/6.
180.
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            JUL21
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          125
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           JUL21
JUL21
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 121-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           JUL21
  162.
184.
185.
                                                                  121 CALL RKUTT2
60 TO 12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          JUL21
JUL21
                                                                125 IF(IARC.EQ.NARC) GO TO 13
IF(JTYP.GT.O) CALL QLAEND
13 CONTINUE
ENOFILE INARK
REWIND INARK
CALL TRJNDQ
RETURN
END
    186.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          JUL21
JUL21
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 13-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        JUL21
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      188.
    109.
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192.
193.
```

| FORTRAN | MATH | CODE | DESCRIPTION | - | | ORAGE | SUBRO | UTINI | USAGE |
|---------------|--------|----------|---|--------------------|----------|-------|---|---|--|
| SYMBOL | SYMBOL | | DESCRIPTION | | BLOC | K LOC | SUBR | CODI | E VAR |
| ALP HA | C. | I | Angle of attack | (RAD)
- | ,/DYNA | /(79 | AEROCI
AL2
ARCIN
CONTRI
ENVPRI
MOMECI
NPLANI
OUTPU'
TRAJII
UT
WRAPUI | N M
N M
D I
D I
E I O
I | ALPHA
ALPHA
ALPHA
ALPHA
ALPHA
ALPHA
ALPHA
ALPHA |
| ALT
 | h | I | Altitude | (FT) | /D | /(94 | OUTPUT
STATES
WRAPUS | Fj | ALT
ALT
ALT |
| AR CDA | Sref | I | Rerodynamic reference area | (FT ²) | / AR CDA | T/(1 | ARCIN
BNDRY
CHECK
FETCH
SALVE
STATEF
UT
WRAPUF | I | SREF
ARCDA
ARCDA
ARCDA
SREF
SREF
ARCDA |
| С | c | ĭ | A forty mord array containing the vector of i.e. the multipliers for the homogeneous solutions. | c's, | /8 | /(11 | BNDRY BRANPT GROPE INTRPT | 1 | 000 |
| • | • | • | - · · . | • | • | | NEWCS
NLDRV
NOMNAL
WRAPUP | | 00000 |
| DT | h | A | Integration step size in quasitime. | | /0 | /(2 |) AL4
INARC
MADAMS
RKUTTI
RKUTTI
SALVE
WRAPUP | R
I
I | H
H
H
H
H
H
DT |
| DTNC | Δτ | ī | Integration interval | (SEC) | /ARCDA | T/(5 |) WRAPUP | 1 | DTMC |
| OTPI | | 1 | Print frequency for trajectory | | /ARCDA | |) WRAPUP | | OTPI |
| GAM | 7 | 1 | Relative flight path angle. | (RAD) | /D | /(92 |) ARCIN
ENVPRO
OUTPUT
STATEF
WRAPUP | 1 | GAM
GAM
GAM
GAM
GAM |
| IT | ۵ | 1 | Heating | (BTU) | /D | /(99 | OUTPUT
Mrapup | | HT
HT |
| ARC | ī | n | Subarc aumber. | | /CMTRL | /(24 | ARCIN
BCOND
BNDRYE
CHECKAB
COSTAB
ENDPT
FORCES
INTRPT
MAGIC
MARCH
QLIVE | M I I I I I I I I I I I I I I I I I I I | IARC
IARC
IARC
IARC
IIARC
IIARC
IIARC
IIARC
IIARC
IIARC
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IIARC
IIARC
IIARC |

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | ST
BLOCK | ORA | GE
LOC | SUBROUTI | VE USAGE |
|-------------------|---------------------|------|--|---------------|---------|-----------|---|--|
| IDAM | | 0 | Optional atmospheric calculations flag.
IDAM = -1: Compute ∂ ³ ρ _m /∂R ³ ;
IDAM = 0: No optional calculations;
IDAM = 1: Compute ∂ ³ ρ _m /∂R ³ , μ _m , ∂μ _m /∂R, etc. | /DYNA | /(| 218) | ARCIN O
ERROR 1
NPLANE O
STATEF I
WRAPUP O | IDAM
IDAM
IDAM
IDAM
IDAM |
| I DP | | 1 | Component number that corresponds to the QL state variable * IDP = 8. | /PC | /(| 4) | INARC I
WRAPUP I | I DP
I DP |
| INARK | | t | Logical unit on which initial and converged arcs are stored. IMARK = 11. | /GLOBA | L/(| 95) | CHECK O
FETCH I
INARC I
MARCH I
WRAPUP I | I NARK
I NARK
I NARK
I NARK
I NARK |
| KODES | | 0 | Not used. | /CNTRL | /(| 56) | GROPE O
NLDRV A
WRAPUP O | KODES
KODES
Kodes |
| KPT | | n | The subarc point number. KPT = 1 on the first point of subarc, and KPT = NPTS on the lest point of the subarc. | /CNTRL | /(| 8) | BCOND OBNDRY OFORCES I MAGIC ORKUTT1 I SALVE MURAPUP M | KPT
KPT
KPT
KPT
KPT
KPT |
| LGAM | λ, | 1 - | Relative flight path angle costate | /D
- · · - | /(
- | 101) | ALI I
ARCIN I
CONTRL I
NLDRV I
OUTPUT I
MRAPUP I | LGAM
LGAM
LGAM
LGAM
LGAM
LGAM |
| LHT | λ_{0} | 1 | Heating costate | /0 | /(| 108) | MLDRY I
WRAPUP I | LHT |
| LA | λ. | I | Mass costate | /0 | /(| 106) | NLDRV I
OUTPUT I
MRAPUP I | LM
LM
LM |
| LAU | λ_{μ} | I | Relative longitude costate | /D | /(| 105) | NLORY I
OUTPUT I
WRAPUP I | LAU
Lau
Lau |
| LPSI | λ _φ | 1 | Relative azimuth angle costate | /0 | /(| 102) | ALI I
ARCIN I
CONTRL I
NLDRV I
OUTPUT I
WRAPUP I | LPSI
LPSI
LPSI
LPSI
LPSI
LPSI |
| LR | λ_{R} | 1 | Aititude costate | /0 | /(| 103) | NLDRY I
OUTPUT I
WRAPUP I | LR
LR
LR |
| LRHO | λ _p | I | Latitude costate | /D | /(| 104) | NLDRY I
OUTPUT I
WRAPUP I | LRHO
LRHO
LRHO |
| LTAU | $\lambda_{_{m{y}}}$ | 1 | Subarc duration costate | /D | /(| 107) | OUTPUT I
Wrapup I | LTAU
Ltau |
| LV | λ, | 1 | Relative velocity costate | /0 | /(| 100) | AL1 I
CONTRL I
NLDRY I
GUTPUT I
WRAPUP I | FA
FA
FA
FA |

1121

| FORTRAN
Symbol | MATH
Symbol | CODE DESI | CRIPTION | BLOCK | AGE
LOC | SUBROUTINE USAGE
SUBR CODE VAR |
|-------------------|----------------|---|--|-----------|------------|---|
| • | • | 1 Mass | (G'S) | /0 /0 | 97) | AL9 I M
AL7 I M
AL9 I M
APPLY I M
APPLY I M
COSTAB I M
COSTAB I M
COSTAB I M
INTRPT I M
MLDRY I M
GUTPUT I M
SALVE I M
STATEF I M
MRAPUP I M |
| non | | A The number of homogene
integrated. | ous solutions currently being | /CNTRL /(| 9) | GROPE O MON
INARC M MON
LINDRY I MON
NOMNAL I MON
SALVE M MON
WRAPUP M MON |
| MU | μ | I Relative longitude | (RAD) | /0 /(| 96) | OUTPUT I MU
POBCOL I MU
WRAPUP I MU |
| * | | I Total number of QL sta
= 10. | te and costate variables. N | /PC /(| 2) | BNDRY I N CHECK J M INARC I M LINDRY I N NLDRY I N NOMNAL I N RKUTTI I M SALVE I N WRAPUP I M |
| NARC | N ₃ | I Number of subarcs in t | he problem. | /GLOBAL/(| 18) | BCOND I MARC BNDRY I MARC CHECK I MARC ENDPT I MARC ENUPRO I MARC INARC I MARC INARC I MARC OLTOSZ I MARC SALVE I MARC SALVE I MARC MARCPI MARC |
| NAUX | | I Number of velocity los on converged trajector | s quantities to be integrated
y. NAUX = 5. | /PC /(| 9) | WRAPUP I NAUX |
| NEWNOM | | O A logical flag that in | dicates to the Runge-Kutta
not the system Jacobian | /CNTRL /(| 15) | INTERP O NEWNOM LINDRY M NEWNOM RKUTTI O NEWNOM SALVE O NEWNOM WRAPUP O NEWNOM |
| NM . | | M The number of quantiti
numerically integrated | es currently being | /CNTRL /(| 52) | BNDRY M NN INARC M NN ADARS I NN MAGIC M NN MAGIC I NN KUTTI I NN KUTTI I NN SALYE M NN WRAPUP M NN |
| NOC . | - | I An array containing a
of free (unknown) stat
the start of each suba | running total of the number
e and costate variables at
rc. | /BLOCK /(| | BNDRY 1 NOC
BRAMPT I NOC
COSTAB 0 NOC
COSTAB 0 NOC
COSTAG 0 NOC
INARC I NOC
INTRPT I NOC
SALVE I NOC
BRAPUP I NOC |

| ORTRAN | MATH | COD | E DESCRIPTION | | <u> </u> | ORAG | E | SUBROU | SUBROUTINE USAGE | | | |
|--------|--------|-----|---|---------------------------|----------|----------|------|--|--------------------|--|--|--|
| SYMBOL | SYMBOL | | DESCRIPTION | | BLOCI | <u> </u> | LOC | SUBR | CODI | VAR | | |
| MPTS | | 0 | The total number of points in the subarc. | | /CNTRL | 11 | 19) | BCOND
BNDRY
FORCES
INARC
MAGIC
SALVE
WRAPUP | M
0
M | NPTS
NPTS
NPTS
NPTS
NPTS
NPTS
NPTS | | |
| PHI | • | I | Bank angle | (RAD) | /DYNA | /(| 80) | CONTRL
OUTPUT
WRAPUP | I | PHI
PHI
PHI | | |
| PSI | * | 1 | Relative azimuth angle. | (RAD) | /0 | /(| 93) | OUTPUT
STATEF
WRAPUP | Ì | PSI
PSI
PSI | | |
| DT - | | n | A twenty word array containing the values
initial arc of the successive subarcs' dur | from the | / D | /(| 171) | I NARC
WR APUP | 0 | QT
QT | | |
| RH0 | P | I | Latitude | (RAD) | /0 | /(| 95) | AL9
OUTPUT
STATEF | I
I
I | RHO
RHO
RHO
RHO | | |
| TIME | | 1 | Trajectory time | (SEC) | /DYNA | /(| 2) | ENVPRO
OUTPUT
PDBCQL
STATEF
WRAPUP | J
I
I | TIME
TIME
TIME
TIME
TIME | | |
| | 1 | A | The quasitime variable. | | /0 | | | AL4 -BNDRY ERROR FETCH FORCES INTERP MADAMS RKUTT1 RKUTT2 STATEF WRAPUP | DIOIMIM MM MM MM I | X X X X X X X X X X X X X X X X X X X | | |
| 0 | to | 1 | Trajectory start time. | (SEC) | /GLOBAI | ./(| 7) | FETCH
INARC
TRAJIN
WRAPUP | Ř | TO
TO
TO | | |
| , | V | 1 | Relative velocity. | (FT/SEC) | /0 | /(| | AL1 AL4 AL4 AL8 AL9 BCOND BRANPT CONTRL ENOPT EN VPRO FINTERPT NLDRV OUTBROUGH STATE STATE | 1 | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | | |
| | | | An 820 word array containing the particula homogeneous solutions being integrated. T 18 words comprise the particular solution. block of 18 words thereafter comprises an independent homogeneous solution. | r and
he first
Each | /4 | π | | GROPE
INARC
MADAMS
GLTOSZ
RKUTT1
SALVE
WRAPUP | | ! | | |

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | BLO | STORA
CK | GE
LOC | SUBROU' | | |
|-------------------|----------------|------|--|-----|-------------|-----------|--|-------------|--|
| ı | Z | М | A 20 mord array used to store the total linear solution from the preceding QL iteration. | /2 | /(| 1) | BNDRY BRANPT ENOPT ENVPRO INTRPT LINDRY NOMNAL RKUTTI SALVE WARPUP | I | 1
1
1
1
1
1
1
1
1
1 |
| ZD | | ī | A 20 mord array containing the vector f(X,Z,W) in Equation 17.1-7 in Voi.I of this document. | /20 | /(| 1) | ENVPRO
LINDRV
OUTPUT
RKUTT2
WRAPUP | 1
1
1 | ZD
ZD
ZD
ZD
ZD |

SUBRØUTINE SIZIN



Purpose

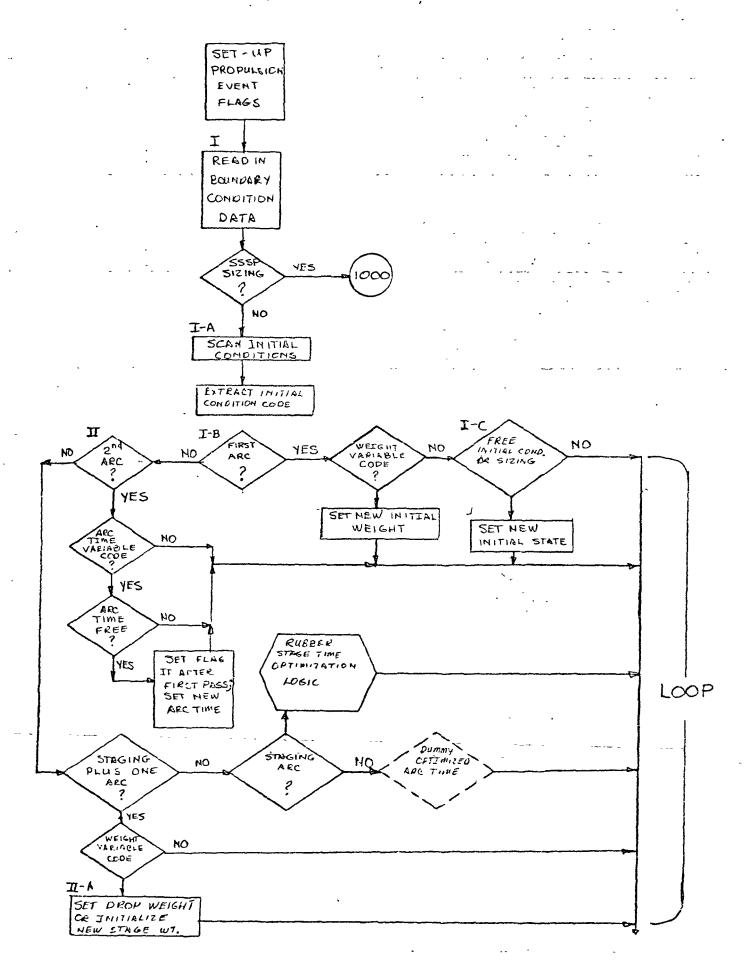
SIZIN is the routine that adjusts trajectory data for sizing solutions.

Description

SIZIN makes necessary changes in several types of trajectory data after each pass through either in the phase I sizing or in the SSSP module.

- 1. Boundary Condition Data
 Vehicle initial weight, cut-off, and drop weights as well as optimized initial states are reset by SIZIN. This is done by scanning for and changing data contained on the boundary condition random access file. This is file 9, record 21.
- 2. Arc Data

Propulsion system and aerodynamic reference areas are modified according to changes generated during sizing, and the modified data is placed back on the arc data random file 9, records 1 through 20.



ARC DATA

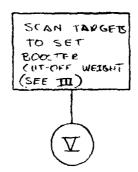
ARC DATA

CONDITION ARRAY

CHARACTERISTICS

SIZIN (CONTINUED)

TARGET SCAN



| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | | STORA
BLOCK | GE
LOC | SUBFOL
SUBF | COD | E VAR |
|-------------------|------------------|-------------------|---|--------------------|----------------|-----------|--|--------------------------------------|---|
| ARCDA | S _{ref} | I Aerodynamic r | eference area | (FT ²) | /ARCDAT/(| 1) | BMTG
EQUAS
FMTG
FXDAT
FXDAT
GEINP
SDINP
SIZIN
SIZIN
THRUST
VT | 1
1
1
2
0
8
1
1 | ARCDA
SREF
ARCDA
ARCDA
I ARCDA
ARCDA
ARCDA
ARCDA
SREF
SREF |
| £1 | Aexit | O Mozzie exit a | *** | (FT ²) | /ARCDAT/(| 2) | PROPB
PROPIN
SIZIN | | E1
E1
E1 |
| FRATE | | O Input rated vo | acuum thrust per engine | (LBS) | /ARCBAT/(| 42) | EQUAS
FXDAT
PROPB
PROPIN
SIZIN | | FRATE
FRATE
FRATE
FRATE
FRATE |
| IPASS | | I Sizing iterati | on counter | | /SIZING/(| 291) | GEIMP
PADS1
PAYU2
SIZE
SIZIM
SSSP | 1 | IPASS
IPASS
IPASS
IPASS
IPASS
IPASS |
| ITAB | | | y containing the number of conditions specified at to the conditions. | | /GLOBAL/(| 45) | GEINP
SDINP
SIZIN | | ITAB
ITAB
ITAB |
| JTYP | | I · Sizing. Flag. | | | /S1Z1NG/(| 313) | FMTG
GEINP
MODELA
PADSI
PROPIN
SIZIN
TRTOSZ | 1
1
1 | 4411
4411
4411
4411
4411
4411
4411 |
| KTAB | | | y containing the number of
ons specified at the end | | /GLOBAL/(| 25) | GEINP
SDINP
SIZIM | | KTAB
KTAB
KTAB |
| SRAN | N ₃ | 1 Number of suba | rcs in the problem. | | /GLOBAL/(| 18) | FNTS
SEINP
PROPIN
SOINP
SIZIN | i
I | NARC
NARC
NARC
NARC
NARC |
| 5 0 | | | ta array (37,5) that contind some injection quantit | | /SIZING/(| | ENVPRMP FLYBKP I SPRAT POBC PRITY POBC PRITY PRI | M1111M00MM1M0MMM | 5589
5589
5589
5589
5589
5589
5589
5589 |

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| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAGE
BLOCK LOC | SUBROUT
SUBR (| TINE USAGE
CODE VAR |
|-------------------|----------------|-----------|-----------------|----------------------|-------------------|------------------------|
| | | | , | | | |
| . UNG6 . | | 0 File of | all output data | /.UN06./(s | BADRYC | 0 .UNO6. |
| | | | | | | 0 .UNO6. |
| | | | | | FRENCH | 0 .UN06. |
| | | | , | • | FXDAT | 0 .UN06. |
| | | • | | | GEINP | 0 .UNO6. |
| | | | | | HUNT | 0 .UNO6. |
| | | | | | | D .UMO6. |
| | | | | | MODELA | |
| | | | | | | 0 .UNG6. |
| | | | | | MPSI | D .UNG6. |
| | | | | | | D .UNO6. |
| | | | | | | D .UN06. |
| | | | | | PRINT
Printy | 0 .UN06.
0 .UN06. |
| | | | | | PRINTW | 0 .UNO6. |
| | | | | | PRITEO | 0 .UNO6. |
| | | | | | PRITVA | D .UNO6. |
| | | | | | PROPIN | 0 .UNO6. |
| | | | | | PROTHR | |
| | | | | | PRWTS#
Range | 0 .UN06.
0 .UN06. |
| | | | | | | 0 .UN06. |
| | | | | | | 0 .UNG6. |
| | | | | | SIZE | 0 .UNO6. |
| | | | | | | 0 .UNO6. |
| | | | | | SIZOUT | 0 .UNO6. |
| | | | | | SOLVE
Splico | 0 .UN06.
0 .UN06. |
| | | | | | | 0 .UNG6. |
| | | | | • | SPLYNE | 0 .UN06. |
| | | | | | SSSP | B .UNDŠ. |
| | | | | | | 0 .UNO6. |
| | | | • | | | 0 .UN06. |
| | | | | | SUMDUT
Tabin | 0 .UNO6.
D .UNO6. |
| | | | | | | 0 .UNG6. |
| | | , | | | | 0 .UNO6. |
| | | | | | WTSCH | D .UNO6. |
| | | | | | MIAOF | D .UNG6. |

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| 1.
2.
3. | ε | PROGRAM SIZIM
THIS PROGRAM ADJUSTS TRAJECTORY DATA FOR SIZING RUNS
REAL MUR MUD ISPR ISPO INVEL NNR NO | SIZIN
SIZIN
SIZING | |
|----------------|----------|--|--------------------------|---------------|
| 4. | | REAL MUB, MUD, ISPB, ISPD, IDVEL,NNB,ND
COMMON /SIZING/ | SIZING | 1 |
| 5. | C | PHASE II SIZING PARAMERERS | SIZING | l |
| 6.
7. | | •TZ, VV(3), GP(14), EROR, PZ(5), VQ, SW(20),
•SV(28), SG(31,5), SE(11), TLMG,
PMASE I SIZING PARAMERERS | SIZING | j |
| 8. | С | +SV(28), SQ(37.5), SE(11), TLAT, TLNG, | SIZING | l . |
| 9. | • | -MAD WIDD DWFB. DWFD. TDLWT. WPB TWRATZ. | SIZING | |
| 0. | | =AK1 AK2 AK3 RK4 ISI7F TRAFIG THRATO | SIZING | i |
| 1. | | #RET DEZ DES. RE4 PREIS 1985 IPSMRX | SIZING |] |
| 2. | | AEXIT, TVACO, NO, MFO, IDVEL, ISPO, ISPB, ** -XPL, TVACB, NNB, MEO, MEB, MO, MLO, MLO, | SIZING | i . |
| 4. | | *DVD. DVR MUB. MUD. VS16. WPD | SIZING | i |
| 5. | | # STYP. BECO. 8516. UKBI. (INBW. (INBW | SIZING | ł |
| 6. | | *SVDPSQ SVDCON , I HUNT , IDPSTG , 1520(19) | UH
Global | |
| 7.
8. | | COMMON/GLÓBAL/ *GR , ER , OMGZ , XLAMRF , YMURF , LUM | GLOBAL | 1 |
| 9. | | *GR | GLOBAL | i |
| ٥. | | *,JJOP(10) FATAL NARC ,NBRAN ,NFARC ,1D(4) *,KTAB(20) TAB(20) ,SIG ,MAXTAB *,KTAB(20) TAB(20) ,SIG ,MAXTAB | GLOBAL | l |
| 1. | | *,GM PSIRF, IPFLG1, IPFLG2, IPFLG3, IPFLG4, INEQFL(20) *, ITPSO #SOI #GLOBL(8) | GLOBAL | ł |
| 2. | | TIPSU ASUL AUGUSTO) | RETAP
Sizin | 1 |
| 4. | | * ITPSO KSÓL KGLOBLÓB) OIMENSIÓN BNARR(400), TARG(100) EQUIVALENCE(BNARR(301), TARG) | SIZIN | I |
| 5. | | COMMON/AR CDAT/ | ARCDAT | l |
| 6. | | *SREF ,EJ ,XISP ,TMULT ,DTMC ,DTPI | ARCDAT | 1 |
| 7.
8. | | *IATM IMODE JAER JPRO OMAX GMAX | ADCDAT | I |
| 9. | | AMAER MAEC MAED MAFF MAFC | TARTORA | l |
| ٥. | | ANT MISP MICE MICE MUND MUND | ARCDAT | I |
| 1. | | | ARCDAT | ſ |
| 2.
3. | | #BHEF MUND KNUW LAMULI KEMAX | ARCDAT
RETAP | |
| ٥.
4. | | DIMENSION ARCOA(40) | ARCOAT | i |
| 5. | | EBUIVALENCE(SREF, ARCDA) | ARCDAT | l |
| 6. | | IF(J)YP.EQ.0) 60 10 10 | SIZIN | 10-7 |
| 7.
8. | | IBECO = SQ(1,1)
IBESP = SQ(1,2) | SIZIN
Sizin | 1 1 |
| 9. | | 15DED = 5P(1.4) | SIZIN | 1 1 |
| 0. | | 15USP = 50(1.5) | SIZIN | 1 1 |
| 1. | | IORBI = \$0(1,3)
IF(JTYP.NE.2) | SIZIN |]] |
| 2.
3. | С | I READ IN BOUNDARY CONDITIONS | OS
SIZIN | 1 1 |
| 4. | | | SIZIN | |
| 5. | | 10 CALL READMS(9, BNARR, 400, 21)
IF(JTYP.E0.2) 60 TO 1000 | SIZIN | 1000 |
| 6. | C | 1-A SCAN INITIAL CONDITION | SIZIN |] |
| 7.
8. | | KI = 0
DD 3001ARC=1,NARC | SIZIN | 1 |
| 8.
9. | | KK= !TAB(!ARC) | SIZIN | 1 |
| ٥. | | IF(KK.EQ.0) 60 70 300 | SIZIN | 300 |
| 1. | | DD 100J=1,KK
1CD = BNARR(#1+1) | SIZIN | |
| 2.
3. | | ICD = BNARR((I+))
IVD = BNARR((I+2) | SIZIN | i |
| 3.
4. | | YZ = BNARR(KI+3) | SIZIN | ł |
| 5. | C | I-B TEST FOR FIRST ARC | SIZIN | l |
| 6. | | IF(IARC.ST.1) 60 TO 200 | SIZIN | 200 |
| 7. | C | 15(140 ME E) CO TO 20 | SIZIN | 20- |
| 8.
9. | C | IF(IVD.NE.5) GO TO 20
I-B SET NEW INITAL WEIGHT | SIZIN
SIZIN | |
| ó: | • | 1F(1CD .ME.2.AND.JTYP .EQ.D) GO TO 90
BMARR(KI+3) = VV(1) | SIZIN | 90- |
| 1. | | BNARR(KI+3) =VV(1) | SIZIN | 1 1 1 |
| 2. | c | 60 TO 90 | SIZIN | 90- |
| 3 | <u> </u> | | SIZIN | الله |
| 4.
5. | | 20 IF(ICD.NE.2.OR.IPASS.LE.2) GO TO 90
GO TO (90,21,21,21,22,22,22),1VD | SIZIN
SIZIN | 21 - 22 - 90- |
| 6.
7. | | 21 BNARR(K1+3) = 50(17, IVD-1)
60 TD 90 | SIZIN | 90- |
| 8. | | 22 BNARR(K1+3) = SQ(17,1VD -2) | SIZIN | |
| 9. | | 60 TO 90 | SIZIN | 90- |
| Ó. | C | II ARCS AFTER FIRST | SIZIN | <u> </u> |
| 1. | | OG IF(IARC.NE.2) GO TO 210 | SIZIN | 216-7 |
| 2. | | IF(IVO.NE.1) 60 TO 90 | SIZIN | 96- |
| 3. | | IF(ICD.NE.2) GO TO 90 | SIZIN | 1 70 |
| | | | | |

| | ı | | | | , ., | |
|----|----------------------|----------|--|-------------------------|-----------|----------|
| | | | | | | |
| I | | | | | | |
| I | 74.
75. | | SQ(13,3)=2.
IF(IPASS.LE.2) 60 TO 90 | SIZIN
SIZIN | 96 | |
| | 76. | | GO TO 90 | SIZIN
SIZIN | 90 | |
| | 78
79.
80 | 210 | IF(IARC.NE.1BESP +1) GO TO 220
IF(IVO.NE.5) GO TO 90
IF(ICO.EQ.1) GO TO 212 | SIZIN
SIZIN
SIZIN | 212-796- | |
| I | 81.
82. | C | II-A DROP WEIGHT SET ICD=5 OR 6
IF(ICD.LT.5.OR.ICD.GT.6) GO TO 90 | SIZIN
SIZIN | 96 | |
| | 83.
84.
85 | С | BMARR(K[+3) = QP(9) - SV(7)
GD TO 90
II-B WEIGHT AT BEGINNING NEXT ARC 15 KNOWN | SIZIN
SIZIN
SIZIN | 96 | <u> </u> |
| | 86.
87. | | BNARR(K1+3) = SV(7)
GO TO 90 | SIZIN
SIZIN | 96 | |
| ľ | 89. | C 220 | 11-C OPTIMAL BOOST TIME DURATION 1F(IARC.NE.IBESP) GO TO 230 | SIZIN | 230- | |
| | 90.
91.
92. | | 1F(1VD.NE.1) GO TO 90
IF(1CD.NE.2) GD TO 90
1F(1PA\$5.LE.2) GO TO 1190 | 5121N
5121N
AAA | 90 | 1190 |
| | 93. | | BMARR(K1+3)=50(18,2)
60 TO 90 | ÜH
S121N | 90 | |
| II | 95.
96. | 230 | 1F(1VD NE.1) 60 TO 90
1F(1CD.NE.2) 60 TO 90 | 5121N
5121N | 7G
90 | |
| H | 97. | C | IF(IPASS.LE.2) GO TO 90 INSERT SPECIAL CODING TO SET OPTIMAL ARC TIMES | SIZIN
SIZIN | 90 | |
| ľ | 100. | 100 | KI=KI + 3
CONTINUE | SIZIN
SIZIN | | 1 |
| | 101.
102.
103. | C 300 | CONTINUE TEST FOR NO SIZING 1F(JYPP.EQ.O) GO TO 800 | 5121N
5121N
5121N | 800 | |
| | 104. | С | III SCAN TARGET CONDITIONS
KT= 0 | SIZIN
SIZIN | |] |
| ſ | 106.
107.
108. | | DO 400 [=1 MARC
KL= KTAB(I)
IF(KL.EQ.O) 60 TO 400 | SIZIN
SIZIN
SIZIN | 400- |] |
| ľ | 109. | | DO 390 J=1,KL
ICD = ICOD(TARG(KT+1)) | SIZIN
SIZIN | | |
| | 1111. | | IVD = IVOD(TARG(KT+1))
IVD=IABS(IVD)
VZ = TARG(KT+2) | 5121N
5121N
5121N | | 1 1 |
| | 114. | | LCD =1ABS(1CD)
1F(1VD.NE.5) GO TO 380 | SIZIN | 380 | 1 1 |
| | 116.
117.
118. | С | IF(I .NE.IBECO) GO TO 380
IF(LCO.NE.I) GO TO 380
III-A BOOSTER CUT-OFF WEIGHT | S1Z1N
S1Z1N
S1Z1N | 380- | |
| | 119. | | TARG(KT+2) = QP(9) KT= KT+2 | SIZIN | | |
| Ľ | 121. | | CONTINUE | SIZIN
SIZIN | | |
| | 123. | | IF(JTYP.EQ.O) GO TO 800
CONTINUE | SIZIN
AAA | 800 | |
| | 125.
126.
127. | C 450 | IV SCAN AND CORRECT THRUST AND ISP WAITE(6,450) FORMAT(1H1,20x,27HARC DATA UPDATED BY SIZE) | SIZIN
SIZIN
SIZIN | | |
| ſ | 128. | 150 | FORMAT(1H1, 20x, 27HARC DATA UPDATED BY SIZE) 00 600 IARC=1 NARC CALL READRS(9 SREF, 51, IARC) | SIZIN | | 1 1 1 |
| l | 130.
131.
132. | c | IF(IARC.GT.IBECQ) GO'TO'510
TEST FOA SOLIOS
IF(SQ(20,1).NE.O. AND.IARC.LE.ISOCO) GO TO 470 | SIZIN
AAA
AAA | 470- | 1 1 1 |
| ١ | 133. | C | IV-A SET ENGINE CHARACTERISTICS (BOOSTER) FRATE= QP(1) | SIZIN
SIZIN | ''' | |
| ١ | 135.
136
137. | | XISP= QP(3)
Tmult=1.
1F(QP(7).NE.0) SREF=QP(7) | SIZIN
SIZIN
SIZIN | | |
| | 138. | | EJ = QP(11)
GO TO 580 | SIZIN
SIZIN | 580-7 | |
| | 140. | C
470 | SOLIO + BOOSTER CHARACTERISTICS FRAT = QP(1)+ SQ(22,4) | AAA | | |
| | 142. | | XISP = TZ
TMULT = 1. | 888
888 | | |
| | C1 - 86 | | | | 111 | 1 1 |

| 14 | . 60 10 5 | | AAA
AAA | 586 |
|-------|------------------------------|--|-------------------------|-------------------------------|
| 14 | | ENGINE ORBITER T. (ORB) GO TO 600 | SIZIN | 666- |
| 11:4 | . FRATE= OP | (2) | SIZIN
SIZIN | |
| 15 | TAULT=1. | NE.O) SREF =QP(8) | SIZIN
SIZIN |]] [] [|
| 15 | IF(QP(12) | .NE.O.) EJ=QP(12) | UH | |
| 15 | . N=IARC | MS(9, SREF, 51, IARC) | SIZIN | |
| 15 | . #ARCDA(42) | O) | 41), SIZIN
SIZIN | |
| 115 | . 1(ARCDA(K) | | SIZIN
SIZIN | |
| 115 | . 70 FORMÁT(//
12.6.9%.4H | 17H DATA FOR SUBARCI3 | .AREA=E1 SIZIN
SIZIN | 1 1 11 |
| 16 | . 210H PRT M
*TN=13.13X | | 9HAER.OP SIZIN
SIZIN | |
| 16 | . 410X,9HMAX | LIFT=E12.6, | SIZIN
X.8HHEAT SIZIN | |
| 16 | 6 RT=E12.6 | .7x,6mgmoot=E13.6/3x,7malfmax=F7.3,11x,7mphimax=,
.cgref=f8.3,1cx, 7mzcgref=f7.3,13x,5mxemg=f8.3/ | | 1 |
| 16 | - 5x, 5HZE | NG=F7.3,12%,6HXTA1L=F8.3,12%,5HDREF=F7.3,11%,6HRE | | 1 1 1 1 |
| 116 | . X15H TÁBL | E NUMBERS/4% 6HAERO AI4,7H AERO BI4,7H AERO CI4,7H
O EI4,7H AERÓ FI4,7H AERO GI4,7H THRUSTI4,7H ISP | H AERO D SIZIM | |
| 17 | B7H XCG | 14,7H ZCGI4/ 4X,6HWIND AI4,7H WIND BI4 | SIZIN
SIZIN | |
| 417 | 600 CONTINUE | | SIZIN | |
| 17 | | THE OUT NEW BOUNDARY CONDITION ARRAY THS(9, BNARR, 400, 21) | SIZIN | |
| 17 | RETURN | 1105 / , Danning 100 / 41 / | SIZIN | |
| 17 | IPAYO =0 | | AAA
A aa | |
| 17 | NSB =0 | | AAA
AAA | |
| 18 | | RRAY TO DETERMINE IF IT IS A BRANCH PROBLEM AND | MAR
Which are | |
| 18 | K1= 0 | CONTAINS PAYOFF | AAA | |
| | . DO 1050
IT= ITAB(| IARC=1, MARC
IARC) | AAA
AAA | |
| L 18 | | 0) 60 TO 1050
=1.IT | AAA
AAA | 1050 |
| 118 | . ICO = BNA | | AAA
AAA | |
| 19 | . IF(ICD.LE | .10) GO TO 1045 | AAA | 1645 |
| 119 | INTB = 2 | | AAA | |
| 119 | | RC -1 | AAA
AAA | 1051- |
| 1419 | 1045 KI= KI +3 | | AAA | - ⁻ |
| L-19 | | , | AAA
AA A | 1,000 |
| 20 | C CHE | CK FOR BRANCH THAT CONTAINS PAYOFF | AAA | 1080 |
| 20 | | | AAA
AAA | Γ |
| Z0 | DO 1075 I | ARC=1, WARC | AAA | 1 |
| 20 | | 0) 60 TO 1075 | AAA
AAA | 1075 |
| 20 | IF(IARC.N | -1/RRC) 60 TO 1070
S(1COD(TARG(KT+1))) | AAA
AAA | 1076- |
| 20 | IFILCD. NE | 1.2) 60 TO 1070
5(1400(TARG(AT+1))) | AAA
AA A | 1070 |
| 21 | IPAYO = L | VD | AAA | 1,,,,_ |
| 21 | | | AAA | 1677 |
| | | | | 1 [] [|
| ii ii | | | | 111 |

| 214. | | CONTINUE | AAA | | |
|---------------|--------|--|------------------------|--------------------|----------|
| 215. | | CALL STPIT(53) | AAA | | |
| 216. | | CONTINUE | 444 | | Ĺ |
| 217. | Ç | CONTINUE V PHASE II INTERFACE | AAA
AAA | ł | |
| 219. | C | V-A SCAM INITIAL CONDITIONS
KI=O | A A A
A A A | } | |
| ~ 221. | | 00 1300 IARC=1,MARC
KK= ITAB(JARC) | AAA | | |
| 222. | | 1F(KK.EQ.O) 60 TO 1300 | AAA | 1300 | |
| 7224.
225. | | DD 1100 J=1,KK
1CD= BNARR(KI+1) | AAA
A aa | 1 | |
| [226. | | IVD= BNARR(K1+2)
VI = BNARR(K1+3) | AAA | 1 | |
| 227. | C | V-B FIRST ARC | AAA | 1 | |
| 229. | | IF(IARC.GT.1) GO TO 1200
IF(IVO.NE.5) GO TO 1120 | AAA
AAA | 1200 | 7 |
| 231. | | BNARR(K1-3)= VV(1)
GO TO 1190 | AAA | | 1 |
| 233. | С | V-C NEW INITIAL STATES | AAA | _1. ↓ | |
| 234. | 1120 | IF(ICD.NE.2.0A.IPASS.LE.2) GO TO 1190 | AAA | 1121-1122 | _ |
| 235. | 1121 | 60 TO(1190,1121,1121,1121,1122,1122,1122),1VD
BNARR(K1+3) = 50(17,1VD-1) | AAA | 1121 1122 | 7] |
| 237. | | 60 TO 1190 | AAA | _L | <u>}</u> |
| 238.
239. | 1122 | BNARR(KI+3) = SQ(17,1VD~2)
GO TO 1190 | AAA | | -I |
| 240. | 1200 | IF(IARC.NE.2) GO TO 1210 | AAA | 1210-1 | |
| 241. | | IF(IVD.NE.1.OR.ICD.NE.2) 60 TO 1190 | FIMI | | |
| 242. | | SQ(13,3)=2.
IF(IPASS.LE.2) GO TO 1190 | FINI | 1 (| |
| 244. | C | V-D OPTIMIZED PITCH-OVER
BNARR(K1+3)= SQ(18,3) | A A A
A A A | 1 1 | |
| 246. | | 60 TO 1190 | AAA | | |
| 247. | | IF(INTB.EQ.2.AND.IARC.GT.NSB) GO TO 1260 | AAA | 1560- | |
| 248. | 1211 | 1F(IARC.NE.1BESP +1) 60 TO 1220
1F(IVD.NE.5) 60 TO 1190 | AAA | 1220 | |
| 250. | • | IF(ICD.EQ.1) 60 TO 1212 | AAA | 1212-7 | |
| 251.
252. | C | V-E DROP WT.
IF(ICD.LT.5.OR.ICD.GT.6) 60 TO 1190 | AAA | [] [] | |
| 253.
254. | | BNARR(K1+3) = VV(2) 1F(1SOSP+1.EQ.IARC.AND.SQ(20,1).NE.O.) BNARR(K1+3)=VV(2)+ SQ(22,3) | 888 | -1 | |
| 255. | | 60 TO 1190 | AAA |]]]] | |
| 256. | 1212 | V-F ARC INITIAL WT.(ORBITER) BNARR(K1+3) = SV(7) | AAA | ─{ } | |
| 258. | | 60 TO 1190 | AAA | - | |
| 259. | C 1220 | V-6 SOLID DROP WT. IF(SQ(20,1).EQ.0.) 60 TO 1230 | AAA | 1230 | |
| 261. | 1160 | IF(1SOSP+1.NE.1ARC) 60TO 1230 | AAA | 1230 | |
| 262.
263. | | 1F(IVO.NE.5) 60 TO 1190
1F(ICO.EO.1) 60 TO 1222 | AAA | 1222 | |
| 1 264. | C | 1 V-M SOLID DROP MT. | AAA | | |
| 265.
266. | | IF(ICD.LT.5.OR.ICD.GT.6) GO TO 1190
BNARR(K[+3) = 50(22,3) | AAA | | |
| 267.
268. | С | GO TO 1190 V-1 INITIAL WT. AFTER SOLID DROP (NO PROVISION FOR THIS) | 888
888 | | |
| 269. | | 60 TO 1190 | AAA | ╼╊╾╌╌┚╽┟ | |
| 270. | С | V-J OPTIMAL BOOST TIME DURATION | AAA | السيب | |
| 271. | 1236 | 1F(IARC.NE.1BESP) 60 TQ1240
IF(IVO.NE.1) 60 TO 1240 | AAA
AAA | 1240 | |
| 273. | | IF(IVD.NE.1) GO TO 1240
IF(ICD.NE.2) GO TO 1190 | AAA | 1 | |
| 275. | | IOPSTG=1
IF(IPASS.LE.2)_60_TO_1190 | HAAA |]] [| |
| 276.
277. | | BNARR(KI+3) = 50(18,2)
GO TO 1190 | FINI | 1 11 | |
| 278. | 1240 | CONTINUE | AAA | - | |
| 279. | C | VI SPECIAL BRANCH TRAJECTORY LOGIC
I-A TEST WHICH BRANCH IS ORBITER | AAA |)) | |
| 280.
281. | | I-A TEST WHICH BHANCH IS DABITEN
-B TEST WHETHER INJECTION ARC | A A A | 1 1 | |

| 262
263
264.
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321
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325
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327
327
328 | If (ARC | AAAA
AAAA
AAAA
AAAA
AAAA
AAAA
AAAA
AAAA
AAAA | 1286—
1265—
1267—
1267—
1289—
1380—
1380—
1380—
1380— | 1211 |
|---|------------|--|---|------|
| | | | | |

Phase I Sizing Module (SIZE)

8

SIZE

CONTENTS

| Subroutine | SIZE |
|------------|--------|
| Subroutine | SIZ1 |
| Subroutine | SIZ2 |
| Subroutine | SIZ3 |
| Subroutine | SIZ4 |
| Subroutine | SIZ5 |
| Subroutine | SIZØUT |
| Subroutine | TAMPAR |

SUBRØUTINE SIZE

SUBROUTINE SIZE SPECIFICATIONS

1. DESCRIPTION

Purpose:

Calls proper subroutine for sizing option specified, checks sizing convergence, and sets print and trajectory flags.

Comments:

This is the main program of the PADS-I sizing routine. The first pass through this routine may use the booster staging velocity or mass ratio as a primary parameter, subsequent passes use the staging and total velocities provided by the trajectory routines of PADS.

If a large step in gross weight is indicated, a special message is printed and a flag set for a second pass through the steepest descent trajectory program. This process is only executed once. If another gross step is required, the case is aborted.

The subroutine may also be terminated by exceeding a maximum number of iterations. This maximum is an input quantity.

Error Notes:

If the specific impulse of each stage is not input, a note stating this is printed and preset values of 425 and 460 sec for the booster and orbiter are used.

Iteration limit reached

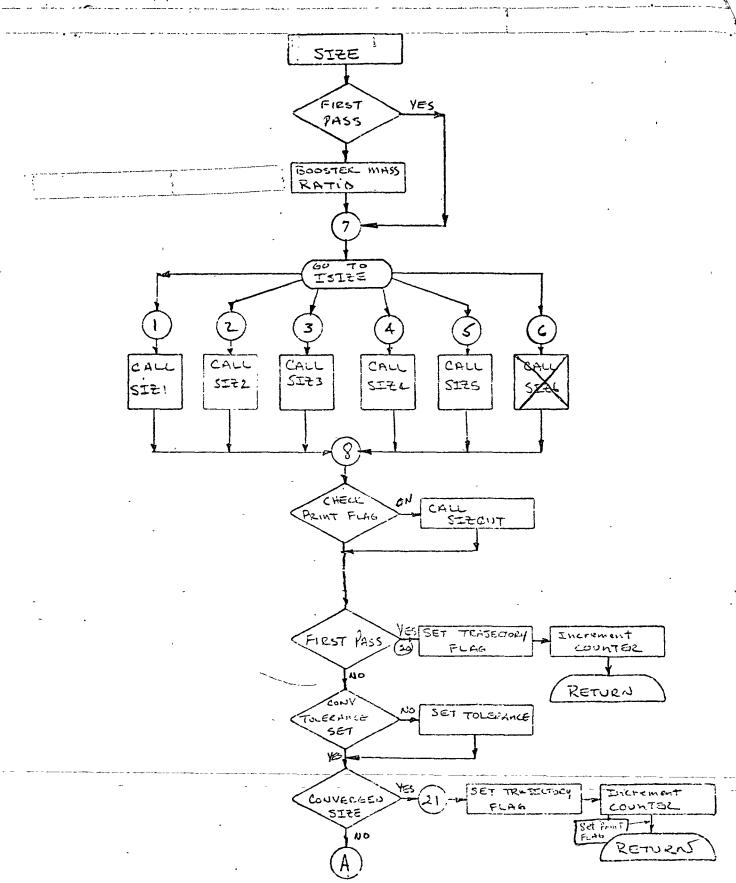
This error indicates that the maximum number of iterations through the sizing routine has been exceeded. This limit may be increased through an input quantity.

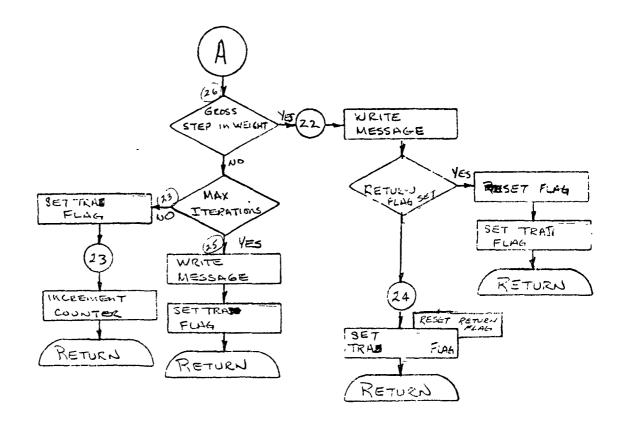
Bad starting guess on staging velocity has resulted in iteration for optimum control parameters

This error is caused by a 40% increase in the initial stage weight required. It is felt that this is an excessive amount and new control parameters would be required to converge the trajectory routines. This path may be followed once. If another gross step is indicated, the job is terminated.

If a gross weight convergence tolerance is not input, a preset value of 0.5 lb. is used.

. N.





3.0 Equations

The sizing requires an initial estimate of the booster mass ratio or staging velocity. If the staging velocity option is used, the following equation is used to determine the initial booster mass ratio

MUB = EXP (MUB/32.174/ISPB)

This equation is also used on the second and following passes through the sizing program since the trajectory program will be returning with the booster staging velocity (VSTG) and not the booster mass ratio.

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORA
BLOCK | LOC | SUBROUT I | NE USAGE
DE VAR |
|-------------------|----------------|-------------------|--|----------------|------|--|---|
| BECO | | I Booste | r cut-off arc | /5121NG/(| 314) | SIZE I | |
| BSTG | | I Booste | r staging arc | /5121NG/(| 315) | SIZE I | BSTG |
| DAT | | I Booste | r burnout meight (lb) | /5121NG/(| 272) | GEINP M
PAYLOD O
SIZE I
SIZOUT I
SIZI M
SIZI M
SIZZ M
SIZZ M | SIZ
WBO
DAT
WBO
WBO
WBO |
| GR | gr | I Gravit | stional acceleration at surface of the earth.
(FT/SEC ²) | | | ACCEL I
BL5 I
EQUAS I
FM3 I
GEINP I
GEINP O
OUT I
PAOS1 I
PAOS1 I
PAOS1 I
SOINP I
SOINP I
SIZ2 I
SIZ2 I
SIZ2 I
SIZ3 I
SIZ4 I
SIZ4 I
SIZ4 I
SIZ4 I | 66 66 66 66 66 66 66 66 66 66 66 66 66 |
| IPASS | | # Sizing | Iteration counter | /S121NG/(| | GEINP O
PADS1 M
PAYO2 I
SIZE M
SIZIN I
SSSP M | IPASS
IPASS
IPASS
IPASS
IPASS
IPASS |
| 1 P S MAX | | A Maziaus | number of iterations | /SIZ1NG/(| 292) | SIZE M
SSSP I
VEHOF I
VEHOF O | IPSMAX
IPSMAX
HIPSMX
IPSMAX |
| ISIZE | | Fixed a
wlo 4. | option flag 1. Fixed wio, maximize xpl 2.
pl, minimize wio 3. Fixed orbiter, minimize
Fixed booster, minimize wio 5. Fixed
O. Maximize xpl 6. Fixed (t/w)1.0.
ne f | /5121NG/(| 283) | SIZE M
SIZOUT I | 151ZE
151ZE |
| I SPB | | M Booster | vecuum specific impulse sec | /\$121NG/(| | SIZE M
SIZOUT 1
SIZ1 I
SIZ2 I
SIZ3 I
SIZ4 I
TAMPAR I | ISPB
ISPB
ISPB
ISPB
ISPB
ISPB
ISPB |
| I SPO | | M Orbiter | vacuum specific impulse sec | /\$1Z1NG/(| | SIZE M
SIZOUT I
SIZI I
SIZZ I
SIZZ I
SIZZ I
SIZZ I | 1 SPO
1 SPO
1 SPO
1 SPO
1 SPO
1 SPO
1 SPO |
| I TNBW | | 0 Booster | empty meght curve no. | /S121NG/(| 317) | | ITNBW
ITNBW
ITNBW
ITNBW |

| FORTRAN
Symbol | MATH
SYMBOL | CODI | DESCRIPTION | <u>ST</u>
BLOC | OR AG | LOC | SUBROI
SUBR | COD | E VAR |
|-------------------|----------------|------|---|-------------------|-------------|---------------|--|-----------------------|--|
| ITMOW | | 0 | Orbiter empty meight curve no. | /5121 N | 6/(| 316) | SIZE
SIZ1
SIZ2
SIZ4
WTDRP | 0
I
I
I | ITMOM
ITMOM
ITMOM
ITMOM
ITMOM
ITMOM |
| MUB | | • | Booster mass ratio or welocity | /SI21N | G/(| 309) | 512E
5121
5122
5123
5124 | H I I R R | MUB
MUB
MUB
MUB
MUB |
| MUO | | • | Orbiter mass ratio | /512IN | 6/(| 310) | S1 ZE
S1 Z1
S1 Z2
S1 Z4 | * * * * | MUD
MUD
MUO
MUO |
| ORBI | | ī | Orbiter Ignition arc | /5121W | 6/(| 316) | REU3
SIZE
VEHOF | 1 1 | 1880
1880
1880 |
| PAFLG | | M | Sizing data print flag 1. Print header 2. Print identifier 3. Print data | /5121# | 6/(| 290) | SIZE
SIZOUT | Ħ | PRFL6
PRFL6 |
| RETFLG | | W | Fing set internally to return for another pass thru
the steepest descent program due to a bad guess in
the sizing | /SIZE | /(* |) | SIZE | H | RETFLG |
| SIZOAT | | 1 | Nemelist block name | /SIZE | /(* | 1 ZE) | SIZE | 1 | SIZDAT |
| 51 ZE | | E | Main program for pads-i sizing overlay. Determines
convergence and calls proper subroutine per isize
fing. | /SIZE | /(+9 | 1 ZE) | SIZE | £ | SIZE |
| SIZOUT | | 5 | Subroutine to formet and print sizing data and headers | /S120U | T/(\$5 | ל דעם | SIZE
SIZOUT | 5
E | SIZOUT
SIZOUT |
| 5121 | | S | Sizing subroutine for fixed liftoff meight sizing option (isize=1) | /5121 | /(\$5 | 1 Z 1) | 512E
5121
\$125 | S
E
S | 5121
5121
5121 |
| 5172 | | S | Sizing subroutine for fixed payload option (isize=2) | /5122 | /(\$5 | 172) | SIZE
SIZZ | S
E | \$122
\$122 |
| 5123 | | S | Sizing subroutine for fixed orbiter sizing option (isize=3) assumes fixed payload. | /5123 | /(\$5 | 123) | 512E
5123 | Ş
E | 5123
5123 |
| 5124 | | S | Sizing subroutine for fixed booster sizing option (isize=4) assumes fixed payload | /5124 | | 124) | 5124 | S
E | 5124
5124 |
| 1 25 | | S | Sizing subroutine for fixed (t/#)0 (isize=5) assumes fixed thrust | /\$125 | /(\$5 | 125) | S I Z 5 | S
E | 5125
5125 |
| 6 | | 0 | A synthesis data erray (37,5) that contains the flyback data and some injection quantities | /S1Z1N6 | 37 (| | ENVPRMF
FLYPRAT VA
FRANCE
PRANCE
SIZEMR
SIZEMR
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T | MIII MOD MMI MOM M MM | 56555555555555555555555555555555555555 |
| OLWT | | | Booster liftoff weight sizing tolerance (1b) | /SIZING | | 276) | | | TOLUT |
| RAFLG | | | Traffic control flag D. Sizing loop not converged 1. Sizing loop converged 2. Error in sizing loop next case | /5121NG | 7(| | FRENCH
ITER8
PADS1
SIZE
SSSP
VEHDF | O
M
O | TRAFLS TRAFLS TRAFLS TRAFLS TRAFLS TRAFLS |

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | BLOCK | FOC | SUBFOU
SUBF | CODE | USAGE
VAR |
|-------------------|----------------|----------|--|---------------------|------|--|---|---|
| VSTG | | I Booste | r staging velocity (fps) | /5121NG/(| 311) | SIZE
TRTOSZ | 1 | VST6
VST6 |
| WL0 | | I Booste | r liftoff weight (1b) | /SIZING/(| 306) | PAYLOD
SIZE
SIZOUT
SIZI
SIZ2
SIZ4
SIZ5
TAMPAR | 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | MT0
MT0
MT0
MT0
MT0 |
| MF00 | | M Previo | us iteration value of booster liftoff meight | /\$121 NG /(| 273) | SIZE | Ħ | MFOD |
| . UNO6. | | O File o | f all output data | /.UNO6./(\$ | | MODELA
MODELA
MODELA
MODELA
PROPERTO
PRINTED
PROPERTO
PROPERTO
PROPERTO
SOLIZE
SIZOUT
SPLIZE
SIZOUT
SPLIZE
SIZOUT
SPLIZE
SIZOUT
SPLIZE
SIZOUT
SUMBOUT
TEST
TEST
WHISTOCK | 000000000000000000000000000000000000000 | - UNO 6 - UNO |

61. 62. 63. 64. 65.

61 (1)

66. 67. 68. 69. 70. 71. 204 CONTINUE MRITE(6,203) ISPO = 460. GO TO 201 SIZE CCC VEHICLE SIZING SUBROUTINES 7 60 TO (1,2,3,4,5) ISIZE SIZE 20 201 72 8.01-46

SIZE

SIZE

SIZE SIZE SIZE SIZE

201-

200

202 CONTINUE
WRITE(6,203)
203 FORMAT(45M SPECIFIC IMPULSE NOT IMPUT DEFAULT VALUE USED)
ISPB = 425.
60 TO 200

| 74.
75. | 1 CALL SIZ | 1 | SIZE | | | | l. |
|---|---|--|--|----------------------|-----|----------|----|
| 16.
11. | 2 CALL 51Z | 2 | SIZE | 1 | - [| | |
| 78.
79. | 3 CALL SIZ | 3 | SIZE
SIZE | 1 | | 1 | 8 |
| 80.
81. | 4 CALL SIZ | 9 | SIZE
SIZE | ! | | | |
| 82.
83. C | 5 CALL SIZ | 5
PRINT TEST ROUTINE | SIZE
SIZE
SIZE | - | · | | J. |
| 85. C
86.
87.
88.
89. C
90. C
91. C | 8 IF(PRFLG
IF (IPAS
IF(TRAFL
VEHICLE | .NE.0) CALL SIZOUT
S.EQ.1) GO TO 20
G.GE.1.) GO TO 999
WT CONVERGENCE TEST
T.EQ.0.0) TOLWT = 10.0 | SIZE
SIZE
SIZE
SIZE
SIZE
SIZE
SIZE
SIZE | 20— | | 7,9, | 9 |
| 93.
94.
95.
96. C | 26 IF (ABS(
IF (IPAS | LIGO - WLO) - TOLWT) 21,21,26
WLOO - WLO)/WLO .GT. 0.40) 60 TO 22
S.LT.1PSMAY) 60 TO 23
W LIMIT REACHED | 512E
512E
512E
512E
512E | 26 —
22 —
23 — | 21— | | |
| 7. C
18.
19.
10.
11. | 25 MRITE(6,
103 FORMAT(3
TRAFLG
RETURM | 103)
2M maximum no. Iterations exceeded)
= 2. | \$12E
\$12E
\$12E
\$12E
\$12E
\$12E
\$12E | | | | |
| 3. C
4. C | NOMINAL
23 TRAFLG | EXIT TO Q-L ROUTIME | SIZE
SIZE | | | | |
| 6.
7.
8. C
9. C | 1PASS =
60 TO 11 | IPASS + 1 | S12E
S12E
S12E
S12E
S12E
S12E | | ;'] | | |
| 2.
3.
4.
5.
6.
7.
8.
9.
0. | *ITERATIO
IF(RETFL
RETFLG =
TRAFLG
CALL TAM
RETURM
SECOND P | 102) 6N BAD STARTING GUESS ON STAGING VELOCITY HAS RESULTED IN N FOR OPTIMUM CONTROL PARAMETERS) 6.EQ.1.0) GO TO 24 1.0 = 0. PAR ASS THRU STEEPEST DESCENT SOLUTION WITH NO CONVERGENCE | \$112E
\$112E
\$112E
\$112E
\$112E
\$112E
\$112E
\$112E
\$112E | 24- | | | |
| 3. C
5.
6.
7. | TERMINAT 24 TRAFLS RETFLS = CALL TAR RETURN | 0. | 512E
512E
512E
512E
512E
512E | | | | |
| 9. C
0. C
1. C
2. C | SET FLAG
SET FLAG | D TRAJECTORY AND SHUTTLE SIZING
S FOR FINAL PASS THRU O-L ROUTINE
S FOR FINAL VEHICLE TRAJECTORY AND PRINT | \$12E
\$12E
\$12E
\$12E | | | | |
| 14.
15.
16.
17. | 21 TRAFLS =
WRITE(6,
9 FORMAT(
PRFLS =
CALL TAM
GO TO 8 | 9) ISIZE
23H PHASE I SIZING OPTION ,I2, 10H CONVERGED)
1. | S12E
S12E
S12E
S12E
S12E
S12E | | | | |
| 40.
41. | 20 TRAFLS | = 0.
1PASS + 1 | SIZE | 1 | _ | <i>_</i> | |
| 42. | 11 CONTINUE | | SIZE | 1- | J | | |

| WLOO = WLO CALL TAMPAR 999 CONTINUE RETURN END | \$12E
\$12E
\$12E
\$12E
\$12E |
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SUBRØUTINE SIZ1

Subroutine SIZ1 Specifications

1.0 DESCRIPTION

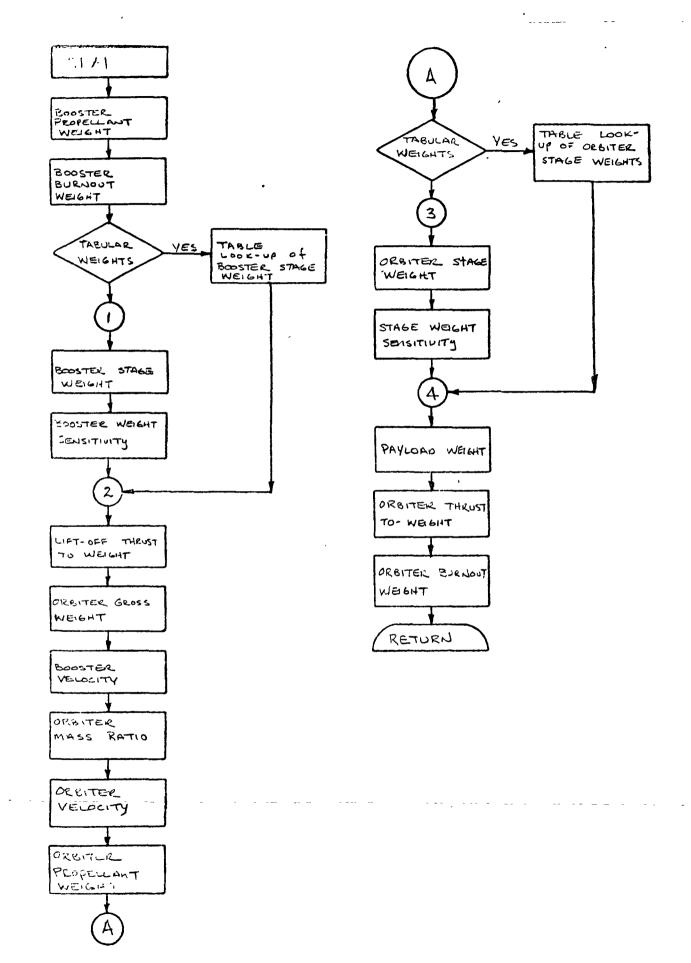
Purpose:

To size a two stage space shuttle with a fixed gross lift-off weight.

Comments:

This routine will size a two stage launch vehicle with a fixed initial weight to perform a given mission. The payload weight is allowed to vary. The two stages are allowed to vary and are described by input weights in a tabular format as a function of propellant weight or the stage weights may be determined by inputing coefficients to a generalized weight scaling equation.

Data transmission to and from this routine is handled by CØMMØN/SIZING/'



3.0 EQUATIONS

The fixed lift-off weight sizing equations are based on impulsive velocity relationships and are solved to maximize the payload delivery capability for the given gross initial weight.

The first quantity calculated is the booster propellant weight using the initial estimate of the booster mass ratio

$$WPB = WLO (MUB-1)/MUB$$

where WLO is the initial gross weight

and MUB is the estimate of the booster stage mass ratio.

The booster burnout weight is determined from

$$WBO = WLO - WPB$$

The booster stage weight is determined from the following generalized weight equation if the coefficients are input. If the coefficients are not input, the stage weight may be input in a tabular format as a function of the stage propellant weight

WEB = BK1 + BK2(WPB) + BK3(WPB)
$$^{1/3}$$
 + BK4(WPB) $^{2/3}$

where BK1 through BK4 are input quantities.

The sensitivity of the booster stage weight to the booster propellant weight is determined by differentiation of the equation above to yield;

DWEB = BK2 +
$$1/3$$
 BK3(WPB)^{-2/3} + $2/3$ BK4(WPB)^{-1/3}

A similar expression is obtained from the tabular weight option if it is used.

The booster thrust to weight ratio at lift-off is calculated from

$$TWRATO = N(TVAC - AEXIT (2116.217))/WLO$$

and the booster inpulse velocity from

$$DVB = 32.2 (ISPB) ALOG (MUB)$$

The initial orbiter weight is found from

$$W/O = WBO - WEB$$

The orbiter mass ratio required to provide the desired mission velocity is determined from

$$MUO = EXP ((IDVEL - DVB)/(32.2 ISPO).$$

The velocity contribution of the orbiter stage to the total mission velocity is

$$DVO = 32.2 ISPO ALOG (MUO).$$

The orbiter propellant weight required is found from

$$WPO = WO (MUO - 1)/MUO.$$

The orbiter stage weight may be determined by the generalized weight equation used to determine the booster weight or may be input in a tabular format. If the generalized equation is used, the coefficients must be input.

WEO =
$$OK1 + OK2(WPO) + OK3(WPO)^{1/3} + OK4(WPO)^{2/3}$$

The orbiter stage weight sensitivity is determined from

DWEO =
$$0K2 + 1/3 OK3(WPO)^{-2/3} + 2/3 OK4(WPO)^{-1/3}$$

The payload weight that corresponds to this estimate of the total mission velocity and booster staging velocity is found from

The orbiter initial vacuum thrust to weight ratio and final burnout weight determinate conclude the SIZ1 routine

$$TWRAT2 = NO (TVACO)/WO$$

$$WFO = WO - WPO$$



| ORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | STORAGE
BLOCK LOC | SUBROUTINE USAGE
SUBR CODE VAR |
|------------------|----------------|---|-----------------------|---|
| AEXIT | | I Booster engine exit area (ft+42) | /S1Z1NG/(29 | 3) SIZI I AEXIT
SIZ2 I AEXIT
SIZ4 I AEXIT
SIZ5 I AEXIT
TAMPAR I AEXIT |
| BK1 | | 1 Value of constant weight in booster stage weigh equation | t /SIZING/(279 |) \$121 BK1
\$122 BK1
WTDRP BK1 |
| BK2 | | I Value of linear term coefficient in booster sta
meight equation | ge /SIZING/(280 |) \$121 |
| IK3 | | I Value of 1/3-power term coefficient in booster
stage weight equation | /S1Z1NG/(281 |) \$121 I BK3
\$122 I BK3
WTDRP I BK3 |
| 347 | | I Value of 2/3-power term coefficient in booster stage weight equation | /SIZING/(282 |) \$121 BK4
\$122 BK4
WTDRP BK4 |
| O¥B | | M Booster idel velecity (fps) | \21 \10 \(308 |) SIZOUT I DVB
SIZI M DVB
SIZZ M DVB
SIZZ O DVB
SIZZ M DVB |
| 940 | | O Orbiter ideal velocity (fps) | /SIZING/(307 |) SIZOUT I DVO
SIZI O DVO
SIZ2 O DVO
SIZ3 M DVO
SIZ4 O DVO
TRTOSZ O DVO |
| WEB | | M Sensitivity of boester stage meight to propellar meight (lb/lb) | nt /SIZING/(274 |) PAYLOD I DWEB
SIZOUT I DWEB
SIZI M DWEB
SIZZ M DWEB
STAU I DWEB
WTDRP M DWEB |
| MED | | M Sensitivity of orbiter stage meight to propellan
meight (lb/lb) | at /SIZING/(275 | PAYLOD I DWED SIZOUT I DWED SIZI M DWED SIZ2 M DWED SIZ4 M DWED MTDRP M DWED |
| я | 9 , | I Gravitational acceleration at surface of the ear
(FT/SE | | ACCEL |
| O¥EL | | 1 Total ideal velocity required to orbit (fps) | /SIZING/(297 |) \$121 |

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| FORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | STORAGE
BLOCK LO | SUBROUTINE USAGE C SUBR CODE VAR |
|-------------------|----------------|--|---------------------|---|
| | | | | |
| ISPB | | I Booster vacuum specific impulse sec | | 99) SIZE M ISPB
SIZOUT I ISPB
SIZI I ISPB
SIZ2 I ISPB
SIZ3 I ISPB
SIZ4 I ISPB
TAMPAR I ISPB |
| 15P0 | | I Orbiter vacuum specific impulse sec | /SIZING/(2 | 98) SIZE M ISPO
SIZOUT I ISPO
SIZ1 I ISPO
SIZ2 I ISPO
SIZ2 I ISPO
SIZ4 I ISPO
TAMPAR I ISPO |
| I I NBM | | l Booster empty meght curve no. | /51Z1NG/(3) | 17) SIZE O ITHBW
SIZI I ITHBW
SIZ2 I ITHBW
WTDRP I ITHBW |
| ITNOW | | I Orbiter empty meight curve no. | /51Z1NG/(31 | 18) SIZE O ITNOM
SIZ1 I ITNOM
SIZ2 I ITNOM
SIZ4 I ITNOM
WTORP I ITNOM |
| MUB | | 1 Booster mass ratio or velocity | /51Z1NG/(30 | 99) SIZE M MUB
51Z1 I MUB
51Z2 J MUB
51Z3 M MUB
51Z4 M MUB |
| MUO | | M Orbiter mass ratio | /S1Z1NG/(3) | 0) SIZE M MU0
SIZ1 M MU0
SIZ2 M MU0
SIZ4 M MU0 |
| NNB | | I Number of booster angines | /\$121NG/(30 | 2) SIZOUT I NNB
SIZI I NNB
SIZZ I NNB
SIZY I NNB
SIZY I NNB
TAMPAR I NNB |
| NO | | I Number of orbiter engines | /SIZING/(29 | 5) SIZOUT I NO
SIZI I NO
SIZZ I NO
SIZZ I NO
SIZZ I NO
TAMPAR I NO |
|)K1 | | I Same as bk1 except for orbiter | /51Z1NG/(28 | 6) SIZI I OKI
SIZZ I OKI
SIZ4 I OKI
MTDRP I OKI |
| JK2 | | I Same as bk2 except for orbiter | /SIZING/(28 | 7) SIZI OK2
SIZ2 OK2
SIZ4 OK2
WTDRP OK2 |
|)K3 | | I Same as bk3 except for orbiter | /SIZING/(28 | 8) SIZ1 I OK3
SIZ2 I OK3
SIZ4 I OK3
WTDRP I OK3 |
| 144 | | 1 Same as bk4 except for orbiter | /S1ZING/(28 | 9) SIZ1 I OK4
SIZ2 I OK4
SIZ4 I OK4
- WTORP I OK4 |
| 121 | | E Sizing subroutine for fixed liftoff meight sizing option (lsize=1) | /5121 /(\$512 | 1) SIZE S SIZI
SIZI E SIZI
SIZ5 S SIZI |

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| ORTRAN
SYMBOL | MATH
Symbol | CODE DESCRIPTION | STORAGE
BLOCK LOC | SUBROUTINE USAGE |
|------------------|----------------|---------------------------------------|----------------------|---|
| TVACB | | I Booster vacuum thrust per engine lb | /SIZING/(301) | S120UT I TYACB
5121 I TYACB
5122 I TYACB
5124 I TYACB
5125 I TYACB
TAMPAR I TYACB |
| T VACO | | I Orbiter vacuum thrust (ib) | /SIZING/(294) | \$120UT I TYACO
\$121 I TYACO
\$122 I TYACO
\$123 I TYACO
\$124 I TYACO
TAMPAR I TYACO |
| WRATO | | O Liftoff thrust-to-meight ratio | /S1Z1MG/(285) | \$120UT I THRATO
\$121 O THRATO
\$122 O THRATO
\$124 O THRATO
\$125 I THRATO |
| WRAT2 | | O Second stOge thrust-to-melght ratio | /\$12IMG/(278) | \$120UT I THRAT2
\$121 0 THRAT2
\$122 0 THRAT2
\$123 0 THRAT2
\$124 0 THRAT2 |
| 180 | | M Booster burnout meight (1b) . | /\$1ZING/(272) | GEINP M SIZ
PAYLOD D MBG
SIZE I DAT
SIZOUT I MBG
SIZI M MBG
SIZI M MBG
SIZ2 M MBG
SIZ4 M MBG
TAMPAR I MBG |
| IE B | | M Booster stage meight (16) | | PAYLOD I WEB
51ZOUT I WEB
51Z1 M WEB
51Z2 M WEB
51Z4 I WEB
TAMPAR I WEB
WTDRP M WEB |
| EO | | M Orbiter stage weight (lb) | ٠ | PAYLOD I WEO SIZOUT I WEO SIZI MEO SIZI MEO SIZI MEO SIZI MEO SIZI MEO SIZI MEO MEO TAMPAR I WEO WTORP MEO WEO |
| FO | | O Orbiter burnout weight (ib) | | PAYLOD M MFO
\$120 T 1 MFO
\$121 O MFO
\$122 O MFO
\$123 O MFO
\$124 M MFO
\$124 M MFO
\$124 M MFO
\$125 O MFO
\$126 MFO |
| LO | | I Booster liftoff e eight (lb) | | PAYLOD 0 WLO SIZE I WLO SIZOUT I WLO SIZI I WLO SIZI M WLO SIZZ M WLO SIZZ M WLO SIZS O WLO TAMPAN I WLO |
| | | A Initial orbiter meight (1b) | | PAYLOD 0 H0
S1ZOUT 1 H0
S1Z1 M H0
S1Z2 M H0
S1Z3 M H0
S1Z4 M H0 |

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| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | <u>Stora</u>
Block | LOC | SUBROU
SUBR | | USAGE |
|-------------------|----------------|---------|---------------------------|-----------------------|------|---|-----------------------|--|
| ШРВ | | M Boost | er propelient weight (lb) | /SIZING/(| 277) | SIZOUT
SIZI
SIZZ
SIZ4
TAMPAR
WTDRP | M | WPB
WPB
WPB
WPB
WPB |
| MPO | | M Orbit | er propellant weight (lb) | /SIZING/(| 312) | SIZOUT
SIZI
SIZZ
SIZ3
SIZ4
TAMPAR
WTDRP | M
M
I
M
I | WPO
WPO
WPO
WPO
WPO
WPO |
| XPL | | 0 Paylo | nd weight (lb) | /\$1Z1NG/(| 300) | SIZOUT
SIZI
SIZZ
SIZZ
SIZZ
TAMPAR | 0
1
1
1 | XPL
XPL
XPL
XPL
XPL
XPL |

```
SIZI
SIZI
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GLOBAL
GLOBAL
                                             SUBROUTINE SIZI
                    CCC
2.
3.
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7.
8.
10.
                                             CONSTANT LIFT-OFF WEIGHT SIZING
                                       GLOBAL
GLOBAL
GLOBAL
RETAP
                                                                                                                                                                                                                                                                                                                         SIZING
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12...
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SIZING
SIZING
                                                                                                                                                                                                                                                                                        TWRAT2,
TWRATO,
IPSMAX,
ISPB,
WLO,
                                                                                                                                                                                                                                                                                                                        SIZING
SIZING
SIZING
SIZING
                                                                                                                                                                                                                                                                                                                         SIZIMG
SIZIMG
                                                                                                                                                                                                                                                                                                                        BOOSTER PROPELLANT WT
                                             MPB = MLO + (MUB-1.)/MUB
                    CCC
                                             BOOSTER BURNOUT MT
                                             WB0 = WL0 - WP8
                    CCC
                                                                                                                                                                                                                                                                                                                        SIZ1
SIZ1
SIZ1
SIZ1
SIZ1
                                             BOOSTER STAGE WT AND SENSITIVITY
                                             IF(BK1.GT.O.O) GO TO 1
CALL SPLIZ( ITMBW, MPB, WEB, DWEB)
GO TO 2
                                                                                                                                                                                                                                                                                                                         ŠIŽI
SIŽI
                                     1 MEB = BK1 + BK2+ MPB+ BK3+ MPB++0.3333+ BK4+ MPB++0.6667
DMEB= BK2 + BK3+ 0.3333+ MPB++(-0.6667)+ BK4+ 0.6667+ MP(-0.3333)
39.
40.
41.
                                                                                                                                                                                                                                                                                                                        SIZI
                                                                                                                                                                                                                                                                                                                        5121
5121
                                     2 CONTINUE
 42.
                                                                                                                                                                                                                                                                                                                         5171
444444555555555556666
                                            TWRATO =NNB+(TVACB- AEXIT + 2116.217)/WLO
DVB = GR + ISPB + ALOG(MUB)
                    C
C
C
                                                                                                                                                                                                                                                                                                                        SIZ1
SIZ1
SIZ1
SIZ1
SIZ1
                                             INITIAL DABITER MT
                                             MO = MBO - MES
                                                                                                                                                                                                                                                                                                                        S121
S121
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S121
                                             ORBITER MASS RATIO
                                             MUO = EXP((IDVEL -DVB)/(GR + ISPO))
DVO = GR + ISPO+ALOG(MUO)
                                                                                                                                                                                                                                                                                                                        5121
5121
5121
                    CCC
                                             ORBITER PROPELLANT WT
                                                                                                                                                                                                                                                                                                                        $121
$121
$121
$121
$121
                                             MP0 = M0 + (MU0-1.0)/MUB
                                             ORBITER STAGE MT AND SENSITIVITY
                                             1F(0K1.6T.0.0) 50 TO 3
Call Spliz(ITNOW, WPO, MEO, DWED)
50 TO 4
                                                                                                                                                                                                                                                                                                                         5121
5121
5121
                                     3 MEO = OK1+ OK2+MPO+ OK3+ MPO++ O.3333+ OK4+ MPO++ O.6667

DMEO= OK2+ O.3333+ OK3+ MPO++(-G.6667)+ G.6667+ OK4+ MPO++

(-0.3333)
64.
65.
                                                                                                                                                                                                                                                                                                                         SIZI
                                                                                                                                                                                                                                                                                                                          5121
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72.
73.
                                                                                                                                                                                                                                                                                                                        $121
$121
$121
$121
$121
$121
                                      4 CONTINUE
                    CCC
                                            PAYLOAD MT
                                             XPL = WO - MPO - MEO
                    C
                                             THRATE = MD+(TVACO)/MO
```

いのか

74. 75. 76. \$121 \$121 \$121 WFO = WO - WPO RETURN END

SUBRØUT INE SIZ2

00 00 00 00 00

Subroutine SIZ2 Specification

1.0 DESCRIPTION

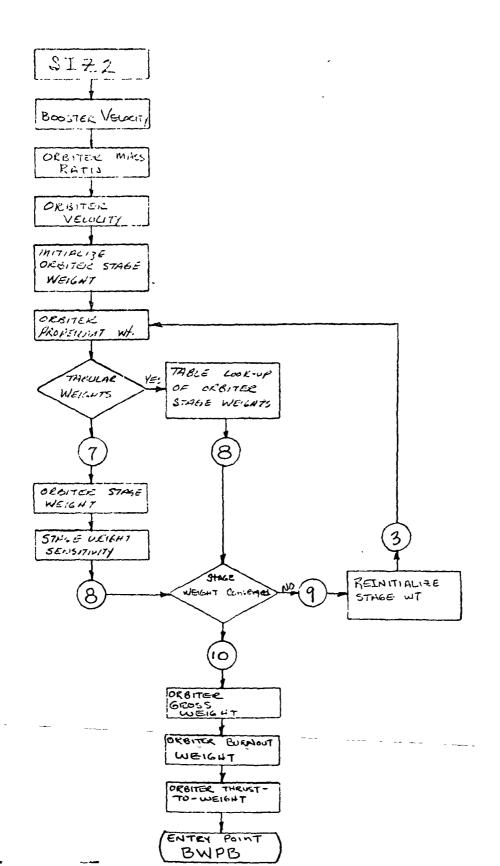
Purpose:

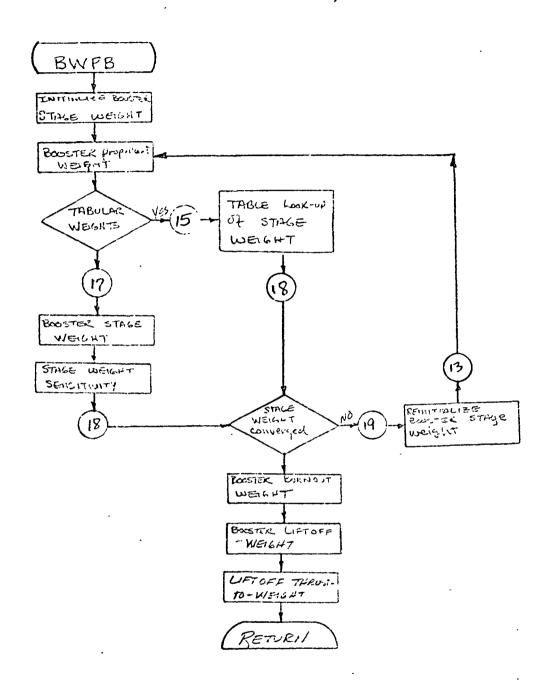
To size a two stage space shuttle with a fixed payload.

Comment:

This routine interates on both stage propellant weights for the input payload weight.

Stage weights may be of a tabular input format or the coefficients of a generalized weight equation may be input.





7:

3.0 EQUATIONS

The solution to the fixed payload sizing problem starts with the determination of the velocity distribution between the booster and the orbiter. The booster velocity is given by

The required orbiter mass ratio to satisfy the mission velocity is given by

$$MUO = EXP ((IDNEL - DVB)/32.2/ISPO$$

AND THE ORBITER VELOCITY IS GIVEN BY

$$DVO = 32.2 ISPO ALOG (MUO)$$

The orbiter propellant weight is solved for iteratively from the following equations

$$WPO = (MUO - 1) (XPL + WEO1)/MUO$$

Where WEOl is an initial estimate of the orbiter stage weight. An orbiter stage weight is calculated with the estimate of the orbiter propellant weight given above. Either the tabular input data of the coefficients for the general weight equation given below must be input to determine the orbiter stage weight

$$WEØ = OK1 + OK2(WPO) + OK3(WPO)^{1/3} + OK4(WPO)^{2/3}$$

and stage weight sensitivity.

DWEO =
$$0K2 + 1/3 OK3(WPO)^{-2/3} + 2/3 OK4(WPO)^{-1/3}$$

This value for WEO is returned to the equation above and solved until

Once the orbiter propellant weight and stage weight has been determined, the initial orbiter-gross-weight may be determined from

$$WO = WEO + WPO + XPL$$

and the orbiter burnout weight from

$$WFO = WO - WPO$$

The orbiter thrust-to-weight ratio is given by

$$TWRAT2 = NO (TVACO)/WO$$

The booster proellant weight is solved for in a similar manner, with the booster stage weight initialized as zero

WEB1 = 0

and the propellant weight determined from

$$WPB = (MUB-1)(WO + WEB1)/MUB$$

Once again the booster stage weight corresponding to this propellant weight is solved for in a similar manner, with the booster stage weight initialized as zero

$$WEBl = 0$$

and the propellant weight determined from

$$WPB = (MUB-1)(WO + WEB1)/MUB$$

Once again the booster stage weight corresponding to this propellant weight is determined from one of the two stage weight options available. Either the booster weight has been input in a tabular format as a function of its propellant weight or the coefficients of the generalized weight law have been input

WEB = BK1 + BK2(WPB) + BK3(WPB)
$$^{1/3}$$
 + BK4(WPB) $^{2/3}$

and the sensitivity of booster weight to propellant weight

DWEB = BK2 +
$$1/3$$
 BK3(WPB) $^{-2/3}$ + $2/3$ BK4(WPB) $^{-1/3}$

the iteration is continued setting WEB1 = WEB until convergence has been obtained. Once converged, the remainder of the booster parameters are determined from

WBO = \cdot W_O + WEB

WLO = WBO + WPB

TWRATO = N(TVAC - AEXIT(2116.217))/WLO.



| DRTRAN | MATH | CODE DES | CRIPTION | STORAG | | SUBROU | IIIN | <u>E USAGE</u> |
|--------------|----------------|---|---|--------------------|-----------|---|---|--|
| SYMBOL | SYMBOL | DE 3 | CNIFIION | BLOCK | LOC | SUBR | COD | E VAR |
| AEXIT | | I Booster engine exit a | rea (ft++2) | /SIZING/(| 293) | SIZ1
SIZ2
SIZ4
SIZ5
TAMPAR | I
I
I
I | AEXIT
AEXIT
AEXIT
AEXIT
AEXIT |
| BK1 | | I Value of constant mei | ght In booster stage weight | /5121NG/(| 279) | | I
I
I | BK1
BK1
BK1 |
| BK2 | | I Value of linear term of meight equation | coefficient in booster stage | /S121NG/(| 280) | SIZI
SIZZ
WIDRP | I
I
I | BK2
BK2
BK2 |
| BK3 | | I Value of 1/3-power ter
stage weight equation | rm coefficient in booster | /SIZING/(| 281) | SIZI
SIZZ
WTDRP | 1
1
1 | BK3
BK3
BK3 |
| 3K4 | | I Value of 2/3-power ter
stage weight equation | rm coefficient in booster | /S121NG/(| 282) | SIZI
SIZZ
WIDRP | I
I
I | BK4
BK4
BK4 |
| SWPB | | E Entry point for booste
(siz2) | er propeliant meight loop | /BWPB /(\$ | S I Z 2) | SI Z 2
SI Z 3 | E
S | BWPB
BWPB |
| OVB | | M Booster idel velocity | (fpe) | /S121NG/(| 308) | SIZOUT
SIZI
SIZ2
SIZ3
SIZ4 |]
M
M
O
M | D 4 B
D 4 B
D 4 B
D 4 B |
|) V O | | O Orbiter ideal velocity | (fps) | /SIZING/(| 307) | SIZOUT
SIZI
SIZZ
SIZZ
SIZZ
TRTOSZ | 0 | DAG
DAG
DAG
DAG
DAG
DAG |
| HEB | | M Sensitivity of booster
weight (ib/ib) | stage meight to propellant | /SIZING/(| 274) | PAYLOD
SIZOUT
SIZI
SIZZ
STAU
WTDRP | I
M
N
I | DWEB
DWEB
DWEB
DWEB |
| WEO | | M Sensitivity of arbiter weight (lb/lb) | stage meight to propellant | /S1Z1NG/(| 275) | | I
M
M | DMEO
OMEO
OMEO
DMEO
DMEO |
| A | 9 _r | I Gravitational accelera | tion at surface of the earth.
(FT/SEC ²) | /GL08 A L/(| | ACCEL
BL5
EQUA3
GEINP
GEINP
GUT
PADS1
PREU3
SDINP
SIZ1
SIZ2
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SIZ3 | 111111111111111111111111111111111111111 | GGRARA AGGRARA |
| | | O Do-loop indes for orbidetermination | ter propellant meight | /\$1Z2 /(+\$ | 122) | S 1 Z 2 | 0 | 1 |

8 NOV 72 G.01-46

| FORTRAN MATE | | STORAGE | SUBROUTINE USAGE |
|--------------------------|---|-------------------|--|
| SYMBOL SYMBI | DE OFFICIAL DESCRIPTION | BFDCK FDC | SUBR CODE VAR |
| IDVEL | I Total ideal velocity required to arbit (fps) | /5121NG/(297) | 5121 1 104EL
5122 1 104EL
5123 1 104EL
5124 1 104EL
5124 1 104EL
TRTOSZ 0 104EL |
| ISPB) | I Booster vacuum specific impulse sec | /51Z1NG/(299) | SIZE M ISPB
SIZOUT I ISPB
SIZI I ISPB
SIZI I ISPB
SIZI I ISPB
SIZI I ISPB
SIZI I ISPB
TAMPAR I ISPB |
| 1SPO |) Orbiter vacuum specific impulse sec | /S12ING/(298) | \$12E M 1SPO
\$120UT I 1SPO
\$121 1 ISPO
\$122 1 ISPO
\$122 1 ISPO
\$124 I ISPO
TAMPAR I ISPO |
| MENTI | I Booster empty meght curve no. | /5121NG/(317) | SIZE O ITNBW
SIZI I ITNBW
SIZZ I ITNBW
WTORP I ITNBW |
| ETNOM | I Orbiter empty meight curve no. | /SIZING/(318) | SIZE O ITNOM
SIZ1 1 ITNOM
SIZ2 1 ITNOM
SIZ4 1 ITNOM
WTDRP 1 ITNOM |
| MUB | I Booster mass ratio or velocity | /SIZING/(309) | SIZE M MUB
SIZI I MUB
SIZ2 I MUB
SIZ3 M MUB
SIZ4 M MUB |
| MUD | M Orbiter mass ratio | /SIZING/(310) | SIZE M MUO
SIZI M MUO
SIZ2 M MUO
SIZ4 M MUO |
| NNB | l Number of booster engines | /SIZING/(302) | SIZOUT I NNB
SIZ1 I NNB
SIZ2 I NNB
SIZ2 I NNB
SIZ4 I NNB
SIZ5 I NNB
TAMPAR I NNB |
| MQ | 1 Number of orbiter engines | | \$120UT 1 NO
\$121 1 NO
\$122 1 NO
\$123 1 NO
\$124 1 NO
\$124 1 NO
\$140 1 NO |
| OK1 | I Same as bkl except for orbiter . | /S121N6/(286) | SIZ1 1 OK1
SIZ2 1 OK1
SIZ4 1 OK1
WTORP 1 OK1 |
| 0 K 2 | I Same as bk2 except for orbiter | | SIZ1 1 0K2
SIZ2 1 0K2
SIZ4 1 0K2
WTDRP 1 0K2 |
| DK3 | I Same as bk3 except for orbiter | | SIZ1 I OK3
S1Z2 I OK3
SIZ4 I OK3
WTORP I OK3 |
| DK4 | I Same as bk4 except for orbiter | | SIZI I OK4
S1Z2 I OK4
S1Z4 I OK4
wforp I ok4 |
| 51Z2
8 NOV 72 6.01-46 | E String subroutine for fixed payload option
(isize=2) | /\$122 /(\$\$122) | S12E S S122
S122 E S122 |

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| FORTRAN
SYMBOL | MATH
Symbol | CODE | DESCRIPTION | STORAG
BLOCK | LOC | SUBROL
SUBR | CODE | USAGE
VAR |
|-------------------|----------------|---------|--|------------------------|------|--|-----------------------|--|
| TVACB | | I Boos | ter vacuum thrust per engine ib | /SIZING/(| 301) | S120ut
S121
S122
S124
S125
TAMPAR | i
i
i | TVACB
TVACB
TVACB
TVACB
TVACB
TVACB |
| TVACO | | I Orbi | ter vacuum thrust (lb) | /SIZING/(| 294) | 51 ZOUT
51 Z1
51 Z2
51 Z3
51 Z4
TAMPAR | I
I
I | TVACO
TVACO
TVACO
TVACO
TVACO
TVACO |
| TWRATO | | 0 Lift | off thrust-to-meight ratio | /SIZING/(| 2851 | SIZQUT
5121
5122
5124
5125 | 0 | TWRATO TWRATO TWRATO TWRATO TWRATO |
| TWRAT2 | | 0 Seco | nd stOge thrust-to-pelight retio | /\$121 N G/(| 278) | SIZOUT
SIZI
SIZ2
SIZ3
SIZ3 | 0 | TWRAT2
TWRAT2
TWRAT2
TWRAT2
TWRAT2 |
| ₩BG | | M Boost | ur burnout meight (ib) | /S1Z1NG/(| 272) | GEINP
PAYLOD
SIZE
SIZOUT
SIZI
SIZZ
SIZZ
TAMPAR | 0
1
1
8 | SIZ
WBD
DAT
WBO
WBO
WBO
WBO |
| WEB | | M Boost | er stage øeight (16) | /5121 N G/(| 304) | PAYLOD
SIZOUT
SIZI
SIZZ
SIZZ
TAMPAR
WIDRP | I
M
I
I | MEB
MEB
MEB
MEB
MEB |
| MEO
MEB J | | | tion variable for booster stage meight
er stage meight (]b) | /S122 /(+
/S121NG/(| | S1IZ PAYLOD S1ZOUT S1Z1 S1Z2 S1Z3 S1Z4 TAMPAR HTDRP | I
M
M
I
M | MED
MED
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MED
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MED |
| WEO 1 | | W Itera | tion variable for orbiter stage seight | /\$122 /(* | | S I Z 2 | | ME01 |
| WF0 | | 0 Orbit | er burnaut meight (1b) | /S1Z1NG/(| | PAYLOB
SIZOUT
SIZI
SIZZ
SIZZ
SIZZ
TAMPAR
TRTOSZ | 0 0
0 0
M 1 | #F0
#F0
#F0
#F0
#F0
#F0
#F0 |
| WLO | | M Boost | er liftoff meight (lb) | /S121W6/(| | | I 4 | #L0
#L0
#L0
#L0
#L0
#L0
#L0 |

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAGE
BLOCK LOC | SUBROUTINE USAGE
SUBR CODE VAR |
|-------------------|----------------|-----------|------------------------------|------------------------|---|
| u o | | # Initia | i orbiter weight (1b) | /SIZ1NG/(305 | PAYLOD D WO
SIZOUT I WO
SIZI M WO
SIZI M WO
SIZI M WO
SIZI M WO
TAMPAR I WO |
| WPB | | M Booster | propellant meight (lb) | /S121NG/(277 |) SIZOUT I WPB
SIZI M WPB
SIZZ M WPB
SIZZ I WPB
TAMPAR I WPB
WTORP M WPB |
| MP () | | M Orbiter | propeliant weight (1b) | /5121 % 6/(312 | SIZOUT I MPO
SIZI M MPO
SIZI M MPO
SIZI M MPO
SIZI I MPO
SIZI M MPO
TAMPAR I MPO
MTORP M MPO |
| x | | W Converg | ence error in stat iteration | /\$122 /(+) | SIZ2 W X |
| XPL | | 1 Payload | weight (lb) | /S121NG/(300) | SIZOUT XPL
 SIZ1 0 XPL
 SIZ2 XPL
 SIZ3 XPL
 SIZ4 XPL
 TAMPAR XPL |

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GLOBAL
6LOBAL
     1.
2.
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                                                              SUBROUTINE SIZZ
                      CC
                                                              CONSTANT PAYLOAD SIZING
                                                     GLOBAL
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RETAP
                                                                                                                                                                                                                                                                                                                                                                                       RETAP

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    13.
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BK4,
OK4,
WFO,
WEO,
MUÓ,
ORBI,
IOPSTG
   18.
19.
20.
                                                       *APL, TYACB, NNB,

*XPL, TYACB, NNB,

*DVO, DVB AUB,

*,JTVP BECO BSTG,

*,SVDPSQ , SVDCON , I HUNT
 21.
22.
23.
24.
25.
                                                                                                                                                                                                                                                                  WEB,
VSTG,
ITNBW
,ISZD(19)
                                                                                                                                                                                                                                                                                                                                                                                                                                  UH

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 24.
25. C
26. C
27. C
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29.
30.
31. C
                                                             ORBITER MASS RATIO
                                                            DVB = GR + ISPB+ ALDG(MUB)
MUO = EXP((IDVEL -DVB)/(GR + ISPO))
DVO = GR + ISPO+ ALOG(MUD)
                                                             ORBITER PROPELLANT WT LOOP
 34.
35.
36.
37.
38.
39.
                                                  ME01=0.0

D0 3 1=1,15

MP0 = (MU0 -1.)*(XPL + ME01)

1F(OK1.GT.0.0) G0 T0 7

5 CONTINUE
                                                             CALL SPLIZ( ITMBM, WPB, WEB, DWEB)
                                                  7 MED = OK1+ OK2* MPO+ OK3*MPO**0.3333 + OK4*MPO** 0.6667

DMEO = OK2+ OK3*0.3333* MPO**(-0.6667)+ OK4*0.6667* MPO**

* (-0.3333)
                                                                                                                                                                                                                                                                                                                                                                                                                                   S122
S122
S122
  41.
  42.
43.
  44.
45.
46.
47.
48.
                                                 8 X = ABS(WEO1+WEO)

IF(X.LT.1) 60 TO 10

9 WEO1= WEO

3 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                   $122
$122
$122
                                                                                                                                                                                                                                                                                                                                                                                                                                    S122
S122
S122
                                                             ORBITER INITIAL WEIGHT
 49.
50.
                                                                                                                                                                                                                                                                                                                                                                                                                                     51 Z2
                                            10 CONTINUE

MO = MPO + MEO + MPL

MFO = MO - MPO

TMRAT2 = NO+(TVACO)/MO
                                                                                                                                                                                                                                                                                                                                                                                                                                    5122
5122
51.
52.
553.
556.
560.
560.
643.
65.
                                                                                                                                                                                                                                                                                                                                                                                                                                  BOOSTER PROPELLANT MT LOOP
                                            EMTRY BMPB
WEB1= 0.0
00 13 1=1,10
MPB = (MUB-1.0)*(MO + MEB1)
1F(BK1.6T.0.0) 60 TO 17
15 CONTINUE
                                           15 CONTINUE

CALL SPLIZ(ITNOW, WPO, WEO, DMEO)
GO TO 18

17 WEB = BK1+ BK2+ WPB+ BK3+WPB++ 0.3337 + BK3+WPB++0.6667
DWEB= BK2+ BK3+0.3333+ WPB++(-0.6667) +BK4+ 0.6667+WPB++

(-0.3333)

18 X = ABS(WEB1-WEB)
IF(X.LT.1) GO TO 20
19 WEB1= WEB
13 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                    5122
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               18-
 66.
67.
68.
                                                                                                                                                                                                                                                                                                                                                                                                                                   5172
                                                                                                                                                                                                                                                                                                                                                                                                                                     5122
69.
70.
71.
72.
73. C
                                                                                                                                                                                                                                                                                                                                                                                                                                  $122
$122
$122
$122
$122
$122
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           20
```

| 75. C | 5122 |
|--|--|
| 76. 20 CONTINUE 77. WBO = MD + MEB 78. C 79. C BOOSTER LIFT-OFF WEIGHT 80. C 81. MLO = MBO + MPB 82. TWRATO = NNB+(TVACB- AEXIT + 2116.217)/MLO 83. RETURN 84. END | \$112
\$112
\$112
\$112
\$112
\$112
\$112
\$112 |

SUBRØUT I NE SIZ3

Subroutine SIZ3 Specifications

1.0 DESCRIPTION

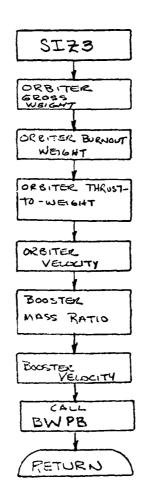
Purpose:

To size a space shuttle launch vehicle with a fixed orbiter stage and payload weight.

Comments:

This routine sizes a booster stage for a given orbiter stage size and payload weight.

The booster propellant weight is determined using the iterative loop in subroutine SIZ2 (entry point BWPB).



3.0 EQUATIONS

The orbiter is specified by its propellant weight and stage weight. The initial and final stage weights are given by

$$WO = WPO + WEO + XPL$$

$$WFO = WO - WPO$$

The thrust-to-weight ratio is given by

$$TWRAT2 = NO(TVACO)/WO$$

and the orbiter velocity is given by

$$DVO = 32.2 ISPO ALOG (WO/WEO + XPL))$$

The required booster mass ratio is determined by

$$MUB = EXP(IDVEL - DVO)/32.2/ISPB)$$

this corresponds to a booster staging velocity of

$$DVB = 32.2$$
 (ISPB) ALOG (MUB).

With this data the propellant weight loop of subroutine SIZ2 is called (entry point BWPB) and the remaining booster parameters determined.

| ORTRAN
Symbol | MATH
SYMBOL | COOE | DESCRIPTION | BLOCK | LOC | <u> 5 0 3 6 0 0</u>
S 0 3 6 | CODE | USAGE
VAR |
|------------------|----------------|----------------|--|---------------------|------------|--|---|--|
| BWPB | | S Entry point | for booster propellant meight loop | /8WP8 /(| \$\$1 ZZ) | S1 Z2
S1 Z3 | E
S | BHPB
BHPB |
| 0 48 | | O Booster ide | velocity (fps) | /5121 4 G/0 | 368) | SI ZOUT
SI ZI
SI ZZ
SI Z3
SI Z4 | | D 4 B
D 4 B
D 4 B
D 4 B |
| OVO | | M Orbiter idea | il velocity (fps) | /S1Z1NG/(| 367) | SIZOUT
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TRIOSZ | 0
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m
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040 |
| S P | 9, | I Gravítationa | i acceleration at surface of the earth. (FT/SEC ²) | /GLOBAL/(| 1) | ACCEL
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GEIMP
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SI | 110111111111111111111111111111111111111 | 66888888888888888888888888888888888888 |
| DAEF | | i Totsi idesi | velocity required to orbit (fps) | /\$121 N G/(| | S1Z1
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S1Z3
S1Z4
TATOSZ | I
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I | IOVEL
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IOVEL |
| SP 8 | | i Booster vacu | um specific impuise sec | /S12146/(| | SIZE
SIZOUT
SIZI
SIZZ
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SIZZ
TAMPAR |]
1
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1 | ISPB
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| SPO | | I Orbiter vacu | um specific impulse sec | /SIZING/(| | | 1
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| ⊍B | | M Booster mass | ratio or velocity | /SIZING/(| | \$121
\$122 | I (| MUB
MUB
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MUB
MUB |
| 0 | | I Number of or | biter engines | /5121MG/(| 295) | 512DUT
5121 | 1 1 | ND
NO
NO
NO
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NO |
| 123 | | | utine for fixed orbiter sixing option cures fixed payload. | /\$123 /(: | | | | 5123
5123 |

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| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAGE
Block loc | SUBROUTINE USAGE
SUBR CODE VAR |
|-------------------|----------------|-----------|------------------------------|-------------------------|--|
| TVACO | | I Orbiter | vacuum thrust (fb) | /SIZING/(294 |) SIZOUT I TVACO
51Z1 1 TVACO
51Z2 1 TVACO
51Z3 1 TVACO
51Z3 1 TVACO
51Z4 1 TVACO
TAMPAR I TVACO |
| TWRAT2 | | D Second | stOge thrust—to-weight ratio | /51ZING/(278 |) SIZOUT I TWRAT2
SIZ1 O TWRAT2
SIZ2 O TWRAT2
SIZ3 O TWRAT2
SIZ4 O TWRAT2 |
| MED | | I Orbiter | stage seight (ib) | /SIZING/(303 | PAYLOB WEO SIZOUT WEO SIZOUT WEO SIZOUT WEO SIZOUT WEO SIZOUT WEO SIZOUT WEO W |
| WF0 . | | O Orbiter | burnout meight (1b) | /\$121 n g/(296 | P PAYLOD M WFO SIZOUT I WFO SIZI O WFO SIZI O WFO SIZI O WFO SIZI M WFO SIZI M WFO TAMPAR I WFO TRIOSZ O WFO |
| MO | | R Initial | orbiter weight (ib) | /SIZING/(305 | P PAYLOD 0 MO
SIZOUT 1 MD
SIZI M MO
SIZ2 M MO
SIZ3 M MO
SIZ3 M MO
TAMPAR 1 MO |
| ⊌PO | | 1 Orbiter | propeliant meight (1b) | /51ZING/(312: | S1ZOUT WPO
 S1Z1 |
| XPL | | I Payload | melght (1b) | /S1Z1NG/(300) | SIZOUT I MPL
SIZI O MPL
SIZZ I MPL
SIZZ I MPL
SIZ4 I MPL
TAMPAR I MPL |

```
SIZE3
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                                                                                                SUBROUTINE SIZ3
CCC
                                                                                              FIXED ORBITER SIZING
                                                                                COMMON/GLOBAL/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       O) GLOBAL
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                                           CCC
                                                                                              INITIAL ORBITER WEIGHT
                                                                                              MO = MPO + MEO + XPL
MFO = MO+ MPO
TMRAT2 = NO+TVACO/MO
                                           CCC
                                                                                              BOOSTER MASS RATIO
                                                                                              DVD = GR + 1SPD+ ALDG(WD/(WED +XPL))
MUB = EXP((10VEL -0V0)/(GR + 1SPB))
DVB = GR +1SPB + ALOG(MUB)
                                           CCC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          512E3
512E3
512E3
512E3
                                                                                              BOOSTER PROPELLANT MT LOOP
                                                                                              CALL BUPB
RETURN
END
```

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SUBRØUTINE SIZ4

Subroutine SIZ4 Specifications

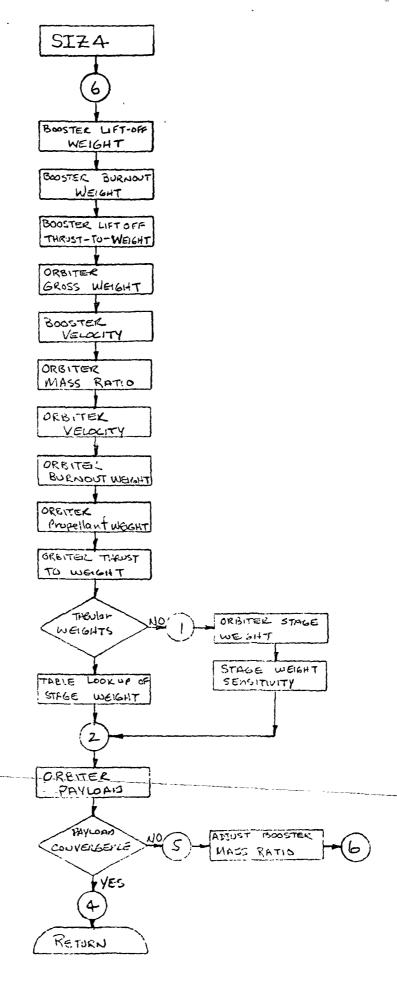
1.0 DESCRIPTION

Purpose:

To size a space shuttle using a fixed booster stage and payload weight.

Comments:

This routine starts with an initial estimate of the booster staging velocity and determines the orbiter size required. The payload value is determined and compared to the required value. If they disagree, the booster staging velocity is changed and the process repeated.



3.0 EQUATIONS

The booster lift-off weight is determined from the initial stage mass ratio estimate and the propellant weight

$$WLO = WPB(MUB)/(MUB-1)$$
.

Next the burnout weight and thrust-to-weight ratio are determined from

WBO = WLO/MUB

TWRATO = N (TVAC - AEXIT (2116.217))/WLO.

The corresponding booster staging velocity is given by

DVB = 32.2 (ISPB) ALOG (MUB).

The initial orbiter weight is given by

WO = WBO - WEB.

The required mass ratio for the orbiter is given by

MUO = EXP (IDVEL - DVB)/32.2/ISPO

which corresponds to an orbiter velocity of

DVO = 32.2 (ISPO) ALOG (MUO).

The orbiter vacuum thrust-to-weight ratio is given by

TWRATZ = NO (TVACO)/WO

and the orbiter burnout and propellant weights are given by

WFO = WO/MUO

 $-WPO = WO_- WFO_-$

At this point the orbiter stage weight and weight sensitivity is determined using the propellant weight and input data. If the tabular stage weight option has been

used these quantities are looked-up, whereas, if the coefficients to the generalized stage weight equation were input,

WEO - OK1 + OK2(WPO) + OK3(WPO)
$$^{1/3}$$
 + OK4(WPO) $^{2/3}$

and

OWEO =
$$OK2 + 1/3 OK3(WPO)^{-2/3} + 2/3 OK4(WPO)^{-1/3}$$
.

The corresponding payload for this iteration is determined from

$$YPL = WFO - WEO$$

if this payload matches the input payload the sizing is complete. If

$$X = XPL - YPL \neq 0$$

then the booster mass ratio is changed in the proper direction by

$$MUB = MUB - X (MUB-1)^2 / WPB$$

and the process is repeated until X is made sufficiently small.

| FORTRAN
SYMBOL | MATH
Symbol | CODE | DESCRIPTION | STORAG
BLOCK | LOC . | SUBROUTI
SUBR CO | NE USAGE
DE VAR |
|-------------------|----------------|-------|--|----------------------|-------|--|--|
| AEXIT | | 1 Bc | poster engine exit area (ft*#2) | /\$171NG/(| 293) | SIZ1 I
SIZ2 I
SIZ4 I
SIZ5 I
TAMPAR I | AEXIT
AEXIT |
| 840 | | M 80 | poster idel velocity (fps) | /S121MG/(| 308) | SIZOUT I
SIZ1 #
SIZ2 #
SIZ3 0
SIZ4 # | DVB
DVB
DVB |
| 040 | | 0 Or | biter ideal velocity (fps) | /SIZING/(| 307) | SIZOUT I
SIZ1 0
SIZ2 0
SIZ3 M
SIZ4 0
TRIDSZ 0 | 0 4 0
0 4 0
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0 4 0 |
| OMEO | | | nsitivity of orbiter stage weight to propellant
light (Ib/Ib) | /5121 N G/(| 275) | PAYLOR I
SIZOUT I
SIZI M
SIZZ M
SIZ4 M
WTDRP M | DWE0
DWE0 |
| SR | 9 _r | 1 Gr | avitational acceleration at surface of the earth. (FT/SEC ²) | /GLDBAL/(| 1) | ACCEL I
BL5 I
EGUAS I
FM3 I
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S | 68 68 68 68 68 68 68 68 68 68 68 68 68 6 |
| IDVEL | | l To | tal ideal velocity required to orbit (fps) | /S1Z1NG/(| | \$121 I
\$122 I
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| ISPB | | 1 80: | oster vecuum specific impulse sec | /51Z1NG/(| | \$12E M
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| 1SPO | | 1 Ort | biter vacuum specific impulse sec | /S121NG/(| | SIZE M
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TAMPAR I | 15P0
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15P0 |
| HONTI | | I Orl | biter empty meight curve no. | /\$121 N \$/(| | SIZE 0
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WIDAP I | WONTI
WONTI
WONTI
WONTI |

| FORTRAN | HTAM | CODE DESCRIPTION | STORA | | SUBROU | TINE USAS |
|---------|--------|--|---------------------|--------|--|--|
| SYMBOL | SYMBOL | DESCRIPTION | BLOCK | LOC | SUBA | CODE VAR |
| MUB | | M Booster mass ratio or velocity | /S111NG/(| 309) | S1ZE
S1Z1
S1Z2
S1Z3
S1Z4 | 8UP P
8UP 1
8UP 1
8UP P
8UP P |
| nuo | | M Orbiter mass ratio | /51Z1NG/(| 310) | \$1 ZE
\$1 Z1
\$1 Z2
\$1 Z4 | M MUO
M MUO
M MUO
M MUO |
| NNB | | I Number of baaster engines | /SIZING/(| 302) | \$121
\$122
\$124
\$125 | I NNB
I NNB
I NNB
I NNB
I NNB |
| NG | | I Number of orbiter engines | /\$1Z1NG/(| 295.) | SIZOUT
SIZI
SIZZ
SIZ3
SIZ4
TAMPAR | 1 NO
1 NO
1 NO
1 NO |
| OK1 | | l Same as bkl except for orbiter | /\$1Z14G/(| 286) | S1Z1
S1Z2
S1Z4
WT DRP | I OKI
I OKI
I OKI |
|) K 2 | | 1 Same as bk2 except for orbiter | /S1Z1#G/(| 287) | 5122
5124 | 1 0K2
1 0K2
1 0K2 |
| DK3 | | I Same as bk3 except for orbiter | /5121NG/(| 288) | 5122
5124 | 1 0K3
1 0K3
1 0K3 |
| OK4 | | I Same as bk4 except for orbiter | /5121NG/(| 289) | S121
S122
S124
WTORP | I 0K4
I 0K4
I 0K4
I 0K4 |
| 5124 | | E Sizing subroutine for fixed booster sizing option
(isize=4) assumes fixed payload | /5124 /(6 | \$1Z4) | 512E
5124 | S 5124
E 5124 |
| TVACB | | I Booster vacuum thrust per engine lb | /SIZING/(| 301) | \$121
\$122
\$124 | I TVACB I TVACB I TVACB I TVACB I TVACB I TVACB |
| TVACO | | l Orbiter vacuum thrust (16) | /\$121 N 6/(| 294) | 5122
5123 | I TVACO
I TVACO
I TVACO
I TVACO |
| TWRATO | | 0 Liftaff thrust-to-weight ratio | /SIZING/(| 285) | 5122
5124 | |
| WRAT2 | | 0 Second stOge thrust-to-weight ratio | /SIZING/(| 278) | 51 Z 2
51 Z 3 | I TWRATE
O TWRATE
O TWRATE
O TWRATE
O TWRATE |

| | CODE DESCRIPTION | STORAGE | | | NE USAGE |
|---------------|--|------------------------|-------|--|---|
| SYMBOL SYMBOL | CODE DESCRIPTION | BLOCK | roc | SUBA CO | DE VAR |
| WBO | M Baoster burnout weight (1b) | /SIZINS/(| 272) | GEIMP MPAYLOD OF SIZE 1 SIZOUT I SIZI MS SIZZ MS SIZZ MT TAMPAR I | MBD
DAT
MBD
MBD
MBD
MBD
MBD |
| MEB | I Booster stage meight (ib) | /\$121NG/(| 304) | | WEB
WEB
WEB
WEB
WEB |
| MEO | M Orbiter stage meight (lb) | /SIZING/C | | PAYLOD I
SIZOUT I
SIZI M
SIZ2 M
SIZ3 I
SIZ4 M
TAMPAR I
HTDRP M | MED
MED
MED
MED
MED |
| MFO | M Orbiter burnout meight (ib) | /S121NG/(; | | PAYLOG M
51ZOUT 1
51Z1 0
51Z2 0
51Z3 0
51Z4 M
TAMPAR 1
TRTOSZ 0 | WF0
WF0
WF0
WF0
WF0
WF0
WF0 |
| aLO | M Booster liftoff welght (1b) | /\$121NG/(3 | | PAYLOD O
SIZE I
SIZOUT I
SIZI I
SIZZ M
SIZY M
SIZ5 O
TAMPAR I | |
| 40 | M Initial orbiter weight (1b) | /SIZING/(3 | | PAYLOD O
SIZOUT I
SIZI M
SIZZ M
SIZZ M
SIZZ M
SIZZ M | 660
660
660
660
660
660
660 |
| 1P 8 | I Booster propeliant meight (16) | /SIZING/< Z | | SIZOUT I
SIZI M
SIZZ M
SIZ4 I
TAMPAR I
WTDRP M | 배우 8
배우 8
배우 8
배우 8
배우 8
배우 8 |
| IPO | M Orbiter propelient meight (lb) | /S1Z1NG/(3 | 312) | SIZOUT SIZI # SIZZ # SIZZ # SIZZ # TAMPAR HTORP # | MPO
MPO
MPO
MPO
MPO
MPO
MPO |
| | W Difference between internally determined payload
and desired value (1b) | /\$1Z4 /(* \$1 | 24) : | 51Z4 # | x |
| PL | I Payload pelght (1b) | /51Z1NG/(3 | | 5120UT 1
5121 0
5122 1
5123 1
5124 1
TAMPAR 1 | XPL
XPL
XPL
XPL
XPL
XPL |
| - | W Abialute value of delta payload | /5124 /(+51 | Z4) S | 5124 W | ¥ |



| FORTRAN
SYMBOL | MATH
Symbol | CODE | DESCRIPTION | STORAGE
BLOCK L | SUBROUTINE USAGE
OC SUBR CODE VAR |
|-------------------|----------------|----------|---|--------------------|--------------------------------------|
| YPL | | W Intern | mi value of payload used to determine stage | /SIZ4 /(+ |) 5174 W YPL |

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```
SIZE4
SIZE4
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GLOBAL
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RETAP
SIZING
SIZING
                                                             SUBROUTINE SIZA
 23.456.789.112.1145.1151.1149.
                              000
                                                             FIXED BOOSTER SIZING
                                                    COMMON/GLOBAL/
                                                                                                                                                                                                                                                                                                                                                                                                                         SIZING
SIZING
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                            C
                                                                                                                                                                                                                                                                                                                                                                                  SH(20),
                              C
                                                                                                                                                                                                                   S
DWEO,
8K4,
0K4,
WFO,
WEO,
MUO,
ORBI,
10PS16
                                                                                                                                                                                                                                                                                                                                                                                 TWRAT2,
TWRATO,
IFSMAX,
ISPB,
WLD,
                                                      *XPL,
*DVO,
*,JTÝP
* SVOPŠO
 21.
22.
23.
24.
                                                                                                                                                                                                                                                                      1520(15)
                                                                                                                                                               , ĭ HŮNŤ
                                                                                                            , SVDCÓN
                                                                                                                                                                                                                                                                                                                                                                                                                          S17E4
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S17E4
S17E4
S17E4
25.
26.
27.
29.
31.
33.
33.
33.
33.
33.
41.
43.
45.
                                                    6 CONTINUE
                             CCC
                                                            BOOSTER LIFT-OFF MT
                                                            HL0 = HPB + MUB/(MUB-1.0)
                             CCC
                                                            BOOSTER BURNOUT WT
                                                            WBO = WLO/MUB
TWRATO =NNB+(TVACB- AEXIT + 2116.217)/WLO
                            C
C
C
                                                            INITIAL ORBITER MT
                                                            WO = WBO - WEB
                             000
                                                            DRBITER MASS RATIO
                                                           DVB = GR + ISPB + ALOG(MUB)
MUO = EXP((IDVEL - DVB)/(GR + ISPO))
DVO = GR +ISPO + ALOG(MUD)
                            CCC
 46.
47.
48.
49.
50.
51.
53.
                                                            ORBITER WTS
                                                            TWRAT2 = NO+ TVACO /WO
WFO = WO/MUO
WPO = MD- WFO
IF(OK1.GT.O.O) SO TO 1
CALL SPLIZ(ITNOW, MPO, MEO, DMEO)
GO TO 2
                                                              GO TO 2
                                                  1 WED = DK1+ DK2=WPO+ DK3=WPO=+0.3333+ DK4=WPO=+0.6667

DMEO = DK2+ DK3=0.3333=WPO=+(-0.6667)+ DK4=0.6667+WPO ==

(-0.3333)
                                                                                                                                                                                                                                                                                                                                                                                                                           SIZE4
SIZE4
SIZE4
SIZE4
SIZE4
SIZE4
54.
55.
56.
57.
58.
59.
                                                           FIXED PAYLOAD ITERATION
                                                  2 YPL = WFO -WEO

X = XPL-YPL

Y = A85(X)

IF(Y.LT.1) GO TO 4

MUB = MUB - X* ((MUB - 1. )**2)/ WPB

GO TO 6
                                                                                                                                                                                                                                                                                                                                                                                                                           SIZE4
SIZE4
SIZE4
SIZE4
SIZE4
SIZE4
 60.
61.
62.
63.
64.
65.
 66.
67.
68.
                                                   4 CONTINUE
RETURN
END
                                                                                                                                                                                                                                                                                                                                                                                                                           SIZE4
SIZE4
SIZE4
```

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SUBRØUT I NE SIZ5

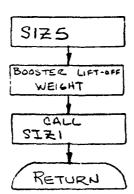
1.0 DESCRIPTION

Purpose:

To size a space shuttle with a given lift-off thrust-to-weight ratio and thrust level.

Comments:

The heart of this routine is the subroutine SIZ1.



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3.0 EQUATIONS

This routine determines the vehicle gross weight from

WLO = NB (TVACB - AEXIT (2116.217))/TWRATO

and solves the fixed gross weight problem of SIZ1.

| FORTRAN
SYMBOL | MATH
SYMBOL C | DDE | DESCRIPTION | 510
8100% | LOC | <u>SUBROU</u>
SUBR | CODE | US A GE |
|-------------------|------------------|----------|--|------------------|-----------|--|----------------------|---|
| AEXIT | | i Booste | r engine exit area (ft**2) | /S121NG | i/(293) | S121
S122
S124
S125
Tampar | I A | EXIT
EXIT
EXIT
EXIT
EXIT |
| MMB | | Number | of booster engines | /S1ZING | 302) | SIZOUT
SIZI
SIZZ
SIZ4
SIZ5
TAMPAR | I NO | NB
NB
NB
NB
NB |
| 5121 | | | subroutine for fixed liftoff meight sizing (isize=1) | /5121 | /(\$51Z1) | S1 ZE
S1 Z1
S1 Z5 | E SI | 1 Z 1
1 Z 1
1 Z 1 |
| \$125 | | | subroutine for fixed (t/m)O (isize=5) s fixed thrust | /\$125 | /(\$5125) | S12E
S125 | | 1 2 5
1 2 5 |
| TVACB | | Booste | r vacuum thrust per engine ib | /SIZING | /(301) | SIZOUT
SIZ1
SIZ2
SIZ4
SIZ5
TAMPAR | I TO
I TO
I TO | VACB
VACB
VACB
VACB
VACB |
| TMRATO | | Liftof | f thrust-to-meight ratio | /SIZING | /(285) | SIZOUT
SIZ1
SIZ2
SIZ4
SIZ5 | 0 ft | HRATO
HRATO
HRATO
HRATO
HRATO |
| mř0 | ŧ | Booste | r liftoff melght (1b) | /SIZ1 N G | /(306) | PAYLOD
S1ZE
S1ZOUT
S1Z1
S1Z2
S1Z4
S1Z5
TAMPAR | 1 #1 | .0
.0
.0
.0
.0 |

985/

SUBRØUT I NE SIZØUT

SUBROUTINE SIZEOUT SPECIFICATIONS

1. DESCRIPTION

Purpose:

To format and print out the PADS-I sizing data.

Comments:

This routine prints identification headers and data for all of the PADS-I sizing routines. A standard output format is used. All data is transmitted to this routine through the CØMMØN/SIZING/statement.

After the first pass through this routine, the print control flag, PRFLG, is set to print data only. The print format is shown in Table I.

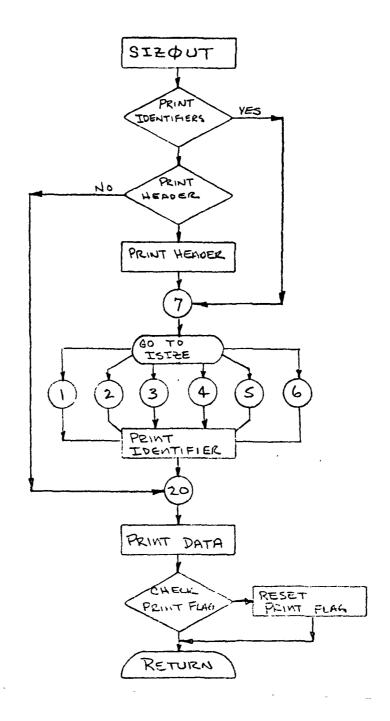
TABLE I

| Subrostive | STROUT | CUTPUT | FORMAT |
|------------|--------|--------|--------|
| | | | |
| | | | |

| PAUS PHASE I SIZ | ING DATA | • |
|--------------------------|------------------|---------|
| SIZING OPTION 3 FI | XED ORBITER | |
| PARAMETER | BOOSTER | ORBITER |
| LIFT-OFF WEIGHT (LB) | (5171072) | 1051220 |
| PROPELLANT WEIGHT (LB) | 3499867 | 827420 |
| BURNOUT MEIGHT (LB) | 1671204 | 223800 |
| STEF WEIGHT (LB) | 619984 | 206605 |
| PAYLUAD WEIGHT (LB) | 1051220 | 17200 |
| SPECIFIC IMPULSE (SEC) | 283 | 436 |
| IMPULSIVE VELOCITY (FPS) | 10293 | 21718 |
| VACUUM THRUST (LB) | 8 09000 n | 1060000 |
| UWE/List | .0057 | 0.0000 |
| (T/≈)L,ö, | 1,2502 | 1,0084 |

RIRST PASS

| PAHALIETER | BOOSTER | ORBITER |
|--------------------------|---------|---------------|
| LIFT-CFF HEIGHT (L6) | 5307158 | 1187158 |
| PROPELLATT (LB) | 3500000 | 942843 |
| BURLOUT WEICHT (LB) | 1807158 | 244315 |
| STEP WEIGHT (LB) | 620100 | 227116 |
| PAYLUAL UFIGHT (LB) | 1187153 | 17200 |
| SPECIFIC IMPULSE (SEC) | 283 | 436 |
| IMPULSIVE VELOCITY (FPS) | 9817 | 22194 |
| /ACUUM THRUST (L6) | 8090000 | 1060000 |
| 0 ME 1 D 14 | ,0057 | ,0288 |
| (1/1),0, | 1.2181 | .892 9 |



3.0 Equations

The only quantity calculated in this routine is the total vacuum thrust for each stage. These quantities are determined from the following equations and used for print purposes only.

Booster:

ABC = NB (TVACB)

Orbiter:

DEF = NO (TVACO)

| ORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | BLOCK | LOC | <u> </u> | INE L | VAR |
|------------------|----------------|------|--|--------------|--------|--|--|----------------------------|
| | | | | | | | | |
| ABC | | u | Total booster vacuum thrustused for printing sizing data | /\$120UT/C | 51Z0) | SIZOUT | W AE | 3 C |
| DEF | | w | Total orbiter vacuum thrustused for printing sizing data | /5120UT/(| \$1Z0) | SIZOUT | w DE | £F |
| DVB | | 1 | Booster idel velocity (fps) | /SIZING/(| 308) | 5123 | I DV
M DV
M DV
D DV
M DV | VB
VB
VB |
| D ¥0 | | 1 | Orbiter ideal velocity (fps) | /SIZING/(| 307) | 5122
5123 | 0 DV | 10
10
10
10 |
| DWEB | | ī | Sensitivity of booster stage weight to propellant weight (lb/lb) | /SIZING/(| 274) | SIZZ
Stau | | IEB
IEB
IEB
IEB |
| DWE0 | | ī | Sensitivity of orbiter stage weight to propellant weight (ib/ib) | /SIZING/(| 275) | SIZOUT
SIZ1
SIZ2
SIZ4 | I DW
I DW
M DW
M DW
M DW
M DW | IEO
IEO
IEO
IEO |
| I S I Z E | | | Sizing option flag 1. Fixed wlo, maximize xpl 2. Fixed xpl, minimize wio 3. Fixed orbiter, minimize wlo 5. Fixed (t/m)1.0. Maximize xpl 6. Fixed (t/m)1.0. Octermine f | /S121N6/(| 263) | SIZE
SIZOUT | | I ZE
I ZE |
| SPB | | | Booster vacuum specific impulse sec | /SIZING/(| 299) | SIZOUT
SIZI
SIZZ
SIZZ | I 151
I 151
I 151
I 151 | PB
PB
PB
PB
PB |
| SPO | | 1 | Orbiter vacuum specific impulse sec | /SIZING/(| 298) | SIZOUT
SIZI
SIZ2
SIZ3 | M 150
I 150
I 150
I 150
I 150
I 150 | PO
PO
PO
PO
PO |
| INB | | 1 | Number of booster engines | /S121NG/(| | SIZOUT
SIZI
SIZZ
SIZZ
SIZZ
SIZ5
TAMPAR | I NNI
I NNI
I NNI
I NNI
I NNI | 8
8
8
8 |
| 10 | | 1 | Number of orbiter engines | /\$121MG/(| | SIZOUT | NO
NO
NO
NO | |
| AFLG | | | Sizing data print flag 1. Print header 2. Print
identifier 3. Print data | /SIZING/(| 290) | SIZE E | A PRE | |
| 1 20 0 T | | E | Subroutine to forest and print sizing data and headers | /\$120UT/(\$ | | SIZE S
SIZOUT E | | ZOUT
ZOUT |

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| FORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | STORAGE
BLOCK LOC | SUBROUTINE USAGE
SUBR CODE VAR |
|-------------------|----------------|---------------------------------------|--------------------------|--|
| TVACB | | I Booster vacuum thrust per engine ib | /S1Z1NG/(301 | SIZOUT I TVACB
SIZ1 I TVACB
SIZ2 I TVACB
SIZ4 I TVACB
SIZ5 I TVACB
TAMPAR I TVACB |
| TVACO | | I Orbiter vacuum thrust (1b) | /SIZING/(294) | |
| TWRATO | | I Liftoff thrust-to-weight ratio | /\$121 n g/(285) | SIZOUT I TWRATO
SIZ1 O TWRATO
SIZ2 O TWRATO
SIZ4 O TWRATO
SIZ5 I TWRATO |
| TWRAT2 | | I Second stOge thrust-to-weight ratio | /S1Z1NG/(278) | SIZOUT I TWRAT2
SIZ1 O TWRAT2
SIZ2 O TWRAT2
SIZ3 O TWRAT2
SIZ4 O TWRAT2 |
| ⊌ 80 | | I Booster burhout meight (lb) | /SIZING/(272) | GEINP M SIZ PAYLOD O MBO SIZE 1 OAT SIZOUT I MBO SIZI M MBO SIZI M MBO SIZI M MBO TAMPAR I MBO |
| WEB | | I Booster stage meight (ib) | /S1Z1NG/(364) | PAYLOD I WEB SIZOUT I WEB SIZI M WEB SIZZ M WEB SIZY I WEB TAMPAR I WEB WIDRP M WEB |
| WEO | | I Orbiter stage meight (lb) | /51Z1NG/(303) | PAYLOD I WEO SIZOUT I WEO SIZ1 M WEO SIZ2 M WEO SIZ3 I WEO SIZ3 I WEO TAMPAR I WEO WEO WEO WEO WEO |
| WFO | | l Orbiter burnout melght (1b) | /51Z1NG/(296) | PAYLOD M WFO
5170UT I WFO
5171 O WFO
5172 O WFO
5173 O WFO
5174 M WFO
TAMPAR I MFO
TRIOSZ O WFO |
| ⊌L0 | | I Booster liftoff melght (ib) | /\$1ZING/(306) | PAYLOD O WLO
51ZE I WLO
51ZOUT 1 WLO
51Z1 I WLO
51Z1 I WLO
51Z2 M WLO
51Z4 M WLO
51Z4 M WLO
51Z5 O WLO
TAMPAR I WLO |
| w 0 | | I Initial orbiter melght (1b) | /\$1ZING/(305)
- | PAYLOD 0 W0
51ZOUT 1 W0
51Z1 M W0
51Z2 M W0
51Z3 M W0
51Z3 M W0
51Z4 M W0 |

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| ORTRAN MATH | CODE DESCRIPTION | STORAGE SUBRO | UTINE USAG |
|---------------|----------------------------------|--|---|
| SYMBOL SYMBOL | DESCRIPTION | N BLOCK LOC SUBA | CODE VAR |
| JP B | I Booster propellant welght (16) | /SIZING/(277) SIZU
SIZI
SIZZ
SIZY
TAMPA
WTORP | M WPB
M WPB
I WPB
R I WPB |
| PO | i Orbiter propeliant meight (lb) | /SIZING/(312) SIZOU
SIZI
SIZZ
SIZ3
SIZ4
TAMPA
WTORP | M WPO
M WPO
I WPO
M WPO
R I WPO |
| PL | I Payload weight (Ib) | /SIZING/(300) 51ZOU
51Z1
51Z2
51Z3
51Z4
TAMPA | O XPL
I XPL
I XPL
I XPL |
| UNO 6. | O File of all output data | /.UNO6./(s BAICO BADRY CRASH FRENCY CRASH FRENCY FRENCY FRENCY FRENCY INTEREST FROM THE PROPERTY OF THE PROPERTY PROPERT | 0 .UNO6. |

_ .

1.00

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SIZOUT
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SIZOUT
SIZOUT
SIZING
SIZING
    1.
2.
3.
9.
5.
6.
7.
8.
                                       SUBROUTINE SIZOUT
                 CCC
                                       PRINT ROUTINE FOR PHASE I SIZING DATA
                                  SIZING
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SIZING
SIZING
SIZING
SIZING
SIZING
SIZING
SIZING
SIZING
                 C
                                                                                                                                                                       PZ(5),
TLNG,
                                                                                                                                                                                                             ٧Đ,
                                                                                                                                                                                                                                              SW(20),
  10.
                 C
                                                                                                                                                                                                            WPB,
TRAFLG,
IPASS,
ISPO,
                                                                                                                                                                                                                                              TWRAT2,
TWRATO,
IPSMAX,
ISPB,
WLO,
                                                                                                                                                                           TOLWT.
                                                                                                                                                                           ISIZE,
PRFLG,
IDVEL,
                                                                                                                                                                       WEB,
VSTG,
ITNBW
                                                                                                                                                                                                            WO,
WPO
  16.
17.
                                                                                                                                                                                                   ITNOW
                                                                                                                                                                    ,1520(14)
                                                                                                                                                                                                                                                                         UH
                                                                                                                                                                                                                                                                         SIZOUT
SIZOUT
SIZOUT
                                       HEADER PRINT
                                      IF(PRFLG.E0.2) 60 TO 7
IF(PRFLG.NE.1) 60 TO 20
WRITE(6,100)
PRFLG = 3.
22.
23.
24.
25.
                                                                                                                                                                                                                                                                         SIZCUT
SIZCUT
SIZOUT
SIZOUT
                                                                                                                                                                                                                                                                                                            126
26,
                               7 60 TO (1,2,3,4,5) ISIZE
                                                                                                                                                                                                                                                                         SIZOUT I
27.
28
                                1 WRITE(6,101)
60 TO 20
                                                                                                                                                                                                                                                                         SIZOUT
                                                                                                                                                                                                                                                                                                                                                        20-
                                                                                                                                                                                                                                                                         SIZOUT
29.
                               2 WRITE(6,102)
60 TO 20
                                                                                                                                                                                                                                                                         SIZOUT
SIZOUT
                                                                                                                                                                                                                                                                                                                                                        20-
31.
32.
                               3 WRITE(6,103)
60 TO 26
                                                                                                                                                                                                                                                                         SIZOUT
                                                                                                                                                                                                                                                                         SIZOUT
                                                                                                                                                                                                                                                                                                                                                        20
                               4 WRITE(6,104)
60 TO 20
33.
34.
                                                                                                                                                                                                                                                                         SIZOUT
                                                                                                                                                                                                                                                                         SIZOUT
                                                                                                                                                                                                                                                                                                                                                        20
35.
                               5 WRITE(6,105)
                                                                                                                                                                                                                                                                         SIZOUT
36.
37.
38.
39.
                            20 WRITE(6,109)
ABC =NNB + TVACB
DEF = ND + TVACD
                                                                                                                                                                                                                                                                         SIZOUT
                                                                                                                                                                                                                                                                         SIZOUT
                 CCC
                                                                                                                                                                                                                                                                         SIZOUT
                      DATA PRINT

WRITE(6,110) MLD, WD, WPB, WPO, WBO, WFO, WEB, WEO, WD, XPL,

15F6,15PO, 6VB, 6VO, ABC, DEF, DWEB, OMEO,

TMRATO, TMRAT2

IF(PRFL6.EQ.2) PRFL6 =3.

100 FORMAT(22X, 24MPADS PHASE I SIZING DATA)

101 FORMAT(2X, 37MSIZING OPTION I FIXED PAYLOAD WEIGHT)

102 FORMAT(2X, 37MSIZING OPTION 2 FIXED PAYLOAD WEIGHT)

103 FORMAT(2X, 31MSIZING OPTION 3 FIXED ORBITER)

104 FORMAT(2X, 31MSIZING OPTION 5 FIXED ORBITER)

105 FORMAT(2X, 31MSIZING OPTION 5 FIXED (T/W)LC)

109 FORMAT(2X, 31MSIZING OPTION 5 FIXED (T/W)LC)

109 FORMAT(16X, 9MPARAMETER 19X, 7MBOOSTER, 11X, 7MORBITER)

110 FORMAT(16X, 24MFROPELLANT WEIGHT (LB), 2(8X, F10.0),/,

16X, 24MBURDOUT WEIGHT (LB), 2(8X, F10.0),/,

16X, 24MSPECHFIC IMPULSE (SEC), 2(8X, F10.0),/,

16X, 24MSPECHFIC IMPULSE (SEC), 2(8X, F10.0),/,

16X, 24MSPECHFIC IMPULSE (SEC), 2(8X, F10.0),/,

16X, 24MSPECHFIC IMPULSE (SEC), 2(8X, F10.0),/,

16X, 24MDWEJOWP (LB), 2(8X, F10.0),/,

16X, 24MDWEJOWP (LB), 2(8X, F10.0),/,

16X, 24MDWEJOWP (LB), 2(9X, F8.4)),

111 FORMAT(1H1)

RETURN

END
                                      DATA PRIMT
                                                                                                                                                                                                                                                                        SIZOUT
SIZOUT
SIZOUT
 41.
 43.
44.
45.
46.
                                                                                                                                                                                                                                                                        $12001
$12001
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$12001
$12001
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$12001
SIZOUT
SIZOUT
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                                                                                                                                                                                                                                                                        SIZOUT
SIZOUT
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SIZOUT
                                                                                                                                                                                                                                                                         $120UT
$120UT
$120UT
                                                                                                                                                                                                                                                                          SIZOUT
```

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SUBROUT INE TAMPAR

Subroutine TAMPAR

1.0 DESCRIPTION

Purpose:

Puts PADS-I data into format compatible with trajectory program interface.

Comments:

This routine corresponds to TAMPER in the PADS-II program (SSSP).

| FORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | STORAL BLOCK | GE SUBROUTINE USAGE |
|-------------------|----------------|--|---------------------------|--|
| 3111000 | 317000 | 5200111172011 | BLUCK | COC 200% CODE ANN |
| AEXIT | | I Booster englne exit area (ft++2) | /S121NG/(| 293) SIZI I AEXIT
SIZ2 I AEXIT
SIZ4 I AEXIT
SIZ5 I AEXIT
I AEXIT |
| ISPB | | I Booster vacuum specific impulse sec | /S121NG/(| 299) SIZE M ISPB
SIZOUT I ISPB
SIZI I ISPB
SIZZ I ISPB
SIZZ I ISPB
SIZZ I ISPB
SIZZ I ISPB
TAMPAR I ISPB |
| 1 SPO | | l Orbiter vacuum specific impulse sec | /S1Z1NG/(| 298) SIZE M ISPO
SIZOUT I ISPO
SIZI I ISPO
SIZZ I ISPO
SIZZ I ISPO
SIZZ I ISPO
TAMPAR I ISPO |
| NNB | | 1 Number of booster engines | /S1Z1NG/(| 302) S1ZOUT I NNB
S1Z1 I NMB
S1Z2 I NMB
S1Z4 I NMB
S1Z5 I NMB
TAMPAR I NMB |
| 10 | | 1 Number of orbiter engines | /SIZING/(| 295) SIZOUT I NO
SIZI I NO
SIZI I NO
SIZI I NO
SIZI I NO
TAMPAR I NO |
| 6 0 | | O A synthesis data array (37,5) that co
flyback data and some injection quant | ntains the /SIZING/(ities | 74) ENVPRM M SQ FLYBKP M SQ ISPRAT I SQ POBC I SQ PRITE O SQ SIZE O SQ SIZEM M SQ SIZEM M SQ STAU I SQ SUMOUT M SQ TAMPAR O SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ TAMPAR M SQ VEMDF M SQ WEMDF M SQ MITOLE M SQ M |
| ٧ | | O A synthesis array (28) containing stag
parameters and misc flags | ging /SIZING/(| 46) ENVPRM M SV FLYBKP I SV ITERS I SV RANGE I SV SIZEMR M SV SIZIN I SV SSSP I SV SUMOUTI SV TAMPER M SV TAMPER M SV TRIOSZ M SV VEHOF M SV UTVOL I SV |
| VACB | | I Booster vacuum thrust per engine lb | /5121#6/(| 301) SIZOUT 1 TVACB
51Z1 1 TVACB
51Z2 1 TVACB
51Z4 1 TVACB
51Z5 1 TVACB
51Z5 1 TVACB |

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAGE | SUBROUTINE USAGE |
|-------------------|----------------|--------------|----------------------|------------------------|--|
| STRIBUL | STHBUL | | BESONIT TION | BLOCK LOC | SUBR CODE VAR |
| TVACO | | 1 Orbiter v | recuum thrust (ib) | /51Z1NG/(294 |) SIZOUT I TVACO
SIZI I TVACO
SIZ2 I TVACO
SIZ3 I TVACO
SIZ4 I TVACO
TAMPAR I TVACO |
| ₩80 | | I Booster b | urnout meight (lb) | /SIZING/(272 |) GEINP M SIZ
PAYLOD O WBO
SIZE I DAT
SIZOUT I WBO
SIZUT M WBO
SIZZ M WBO
SIZZ M WBO
SIZZ M WBO
TAMPAR I WBO |
| WEB | | I Boosters | tage weight (ib) | /SIZING/(304 | PAYLOD I WEB SIZOUT I WEB SIZI M WEB SIZZ M WEB SIZZ M WEB SIZZ M WEB TAMPAR I WEB WTDRP M WEB |
| MEO | | 1 Orbiter s | tage meight (16) | /51Z1MG/(303 |) PAYLOD I WED SIZOUT I WED SIZI M WED SIZI M WED SIZ3 I WED SIZ4 M WED TAMPAR I WED WTDRP M WED |
| uf O | | 1 Orbiter b | urnout meight (lb) | /SIZING/(296 |) PAYLOB M WFO SIZOUT I WFO SIZI O WFO SIZI O WFO SIZI O WFO SIZI O WFO TAMPAR I WFO TRIOSZ O WFO |
| √L O | | l Booster i | iftoff selght (ib) | /\$1Z1NG/(30 <i>6</i> | D PAYLOD D WLD SIZE I WLD SIZOUT I WLD SIZI I WLO SIZI MLO SIZI MLO SIZY MLO SIZY MLO SIZY MLO SIZY MLO |
| 40 | | I Initial or | biter meight (1b) | /SIZING/(305 | PAYLOD 0 WU
SIZOUT 1 WD
SIZI M WD
SIZI M WO
SIZI M WO
SIZI M WO
SIZI M WO
TAMPAR (WO |
| 4P B | | I Booster pr | opellant meight (1b) | /SIZING/(277) | SIZOUT I WPB SIZI M WPB SIZZ M WPB SIZY I WPB TAMPAR I WPB WTORP M WPB |
| 1P 0 | | l Orbiter pr | opellant seight (lb) | /SIZING/(312) | SIZOUT I WPO
SIZ1 M WPO
SIZ2 M WPO
SIZ2 I WPO
SIZ3 I WPO
SIZ4 M WPO
TAMPAR I WPO
WTORP M WPO |

FORTRAN SYMBOL CODE DESCRIPTION STORAGE SUBROUTINE USAGE BLOCK LOC SUBR CODE VAR

XPL 1 Payload seight (1b) /SIZING/(300) SIZOUT 1 XPL SIZ2 1 XPL SIZ3 1 XPL SIZ4 1 XPL TAMPAR I XPL

```
IAMPAR
TAMPAR
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SIZING
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TAMPAR
SUBROUTINE TAMPAR
                                                                                                                                                                                                                      SUBRUCTINE TARPAN

SUBROUTINE TO INTERFACE WITH TRAJECTORY PROGRAM

REAL MUB. MUD. ISPB, ISPO, IDVEL, NNB, ND

COMMON /SIZING,

PHASE II SIZING PARAMERERS

*TZ, V4(3), 3P(14), EROR, PZ(5), V0,

*SV(20), 59(3), 5), SE(11), TLAT, TLNG,

*HRSE I SIZING PARAMERERS

*HBO, WLOO, DWEB, DWED, TOLMT, WPB

*8K1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, TRA

*OK1, BKZ, BK3, BK4, ISIZE, BK3

**SVD, BKZ, BK3, BK4, ISIZE, BK3

**SVD, BKZ, BK3, BK4, ISIZE, BK3

**SVD, BKZ, BK3, BK4, ISIZE, BK3

**SVD, BKZ, BK3, BK4, ISIZE, BK3

**SVD, BKZ, BK3, BK4, ISIZE, BK3

**SVD, BKZ, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK3, BK4, ISIZE, BK3

**SVD, BK3, BK3, BK3, BK3, BK4, BK3

**SVD, BK3, BK3, BK3, BK3, BK
                                                                                                                     C
                                                                                                                     С
                                                                                                                     C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WPB,
TRAFLG,
IPASS,
ISPO,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          MO,
MPO
ITNOM,
                                                                                                                                                                                                                                  * SUDPSO , SYDCON , I

VY(1) = WLO

YY(2)=WEB

VY(3)=WPB

QP(1) = TYACB*NNB

QP(2) = TYACD *NO

QP(3) = 1SPB

QP(4) = ISPB

QP(4) = ISPB

QP(10) = XPL

QP(11) = AEXIT

SY(4) = WFO

SY(5) = WFO

SY(7) = WO

RETURM

END
                                                                                                             ε
```

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Space Shuttle Synthesis Module (SSSP)

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CONTENTS

| Subroutine | SSSP |
|------------|--------|
| Block | CINPUT |
| Block | DATA2X |
| Block | EMS |
| Block | JUMPY |
| Block | ØRBINX |
| Block | ØRBINY |
| Block | ΡØ |
| Block | PRESET |
| Block | SUMVW |
| Block | TAMP |
| Block | TRUST |
| Block | VØLCAL |
| Block | WTCALC |
| Subroutine | DATAIN |
| Subroutine | FLYBKP |
| Subroutine | FRENCH |
| Subroutine | HUNT |
| Subroutine | ITER8 |
| Subroutine | ØPWELL |
| Subroutine | PRINTV |
| Subroutine | PRINTW |
| Subroutine | PRITEQ |
| Subroutine | PRITVA |
| Subroutine | PRØTHR |
| Subroutine | PRWTSM |
| Subroutine | RANGE |
| Subroutine | SETØ |
| Subroutine | SIZEMR |
| Subroutine | SØL.VE |
| Subroutine | STØRE |
| Subroutine | SUMØUT |
| Subroutine | TAMPER |

Subroutine TBL2D
Subroutine THRUP
Subroutine THRUST
Subroutine VEHDF
Subroutine WTSCH
Subroutine WTVØL

SUBRØUT I NE SSSP

| FORTRAN | MATH | CODE DESCRIPTION | STORAS | | SUBFOU | IIIN | E USAGE |
|------------|--------|---|---------------------|------|--|---------------------------------|--|
| SYMBOL | SYMBOL | DE SCHIFFIUM | BLOCK | roc | SUBR | COD | EVAR |
| A | | D Booster sub-somic 1/d | /DATA2X/(| 1) | SSSP
VEHDF
VEHDF | D
m
I | A
A
ALD |
| IHUNT | | I Number of iterations for parameter hunt | /5121NG/(| 321) | GEINP
OPMELL
SSSP | 0
I
I | I HUMT
ELIM
I HUMT |
| IPAS\$ | | M Sizing iteration counter | /\$121 n G/(| 291) | GEINP
PADS1
PAYO2
SIZE
SIZIN
SSSP | 0
M
I
M | IPASS
IPASS
IPASS
IPASS
IPASS
IPASS |
| IPSMAX | | I Maximum number of iterations | /SIZING/C | 292) | SIZE
SSSP
VEHDF
VEHDF | i
i
o | IPSMAX
IPSMAX
HIPSMX
IPSMAX |
| SSSP | | E Main program of phase li paos sizing program overlay(5,0) | /SSSP /(\$ |) | SSSP | E | SSSP |
| SUMOUT | | S Subroutine to print summery data and calculate thrust for output purposes only | /SUMOUT/(\$ |) | SSSP
Sumout | E | SUMBUT
SUMBUT |
| S V | | I A synthesis array (28) containing staging parameters and misc flags | /S1Z1NG/(| 46) | | I
I
I
I
I
I
I | 224
224
224
224
224
24
24 |
| TB27 | | 1 Stored booster value of isp(i) | /ORB] NY/(| 41) | SUMOUT
TAMPER
VEHDF | I
F
I
I | TB27
TB27
TB27
TB27
TB27
TB27
TB27 |
| T 8 3 4 | | A Stored booster value of er(i) | /0R8IMY/(| 53) | FLYBKP
ITERB
SSSP
STORE
SUMOUT
TAMPER
VEHOF
WIVOL | 0
M
I
I | 1834
1834
1834
1834
1834
1834
1834 |
| 1027 | | I Stored orbiter value of isp(i) | /ORBINX/(| 41) | SUMOUT
VEHDF | i
M
1
M | 1027
1027
1027
1027
1027
1027 |
| 1034 | | D Stored orbiter value of mr(1) | /ORBINX/(| 53) | SSSP
STORE
TAMPER
VEHOF | M
0
M
1
0 | T034
T034
T034
T034
T034
T034 |
| IRAFLG | | Traffic control flag 0. Sizing loop not converge
1. Sizing loop converged 2. Error in sizing loonest case | | | PADS1
SIZE
SSSP | 0
I
M
0 | TRAFLG
TRAFLG
TRAFLG
TRAFLG
TRAFLG
TRAFLG |

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| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAGE
Block | SUBROUTINE USAGE
LOC SUBR CODE VAR |
|-------------------|----------------|-----------|-----------------|------------------|---|
| WGR050 | | 1 Orbiter | gross meight | /TAMP /(| 1) SSSP 1 WGROSD
SUMOUT 1 WGROSO
WTVOL M WGROSO |
| WPAYLO . | | I Payload | seight | /SUMWW /(| 16) SSSP I WPAYLO
SUMOUT I WPAYLO
TAMPER M WPAYLO |
| . UNO6. | | O File of | ell output data | /.UN06./(\$ | BLICO |
| | | | | | WISCH O .UNO6.
WIVOL O .UNO6. |

<u>ن</u> د) سرا

```
1.
2. C
3. C
4. C
                                                                                                          PROGRAM SSSP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 SSSP
SSSP
SSSP
SSSP
                                                                                        DRIVER SUBROUTINE FOR PHASE 2 DADS SIZING PROGRAM
CALCULATES FLYBACK FUEL REQUIRED

DIMENSION SSPDAT(1)
EQUIVALENCE (SSPDAT(1), TB1)
REAL MUB, MUD, ISPB, ISPD, IDVEL, MNB, NO
COMMON /SIZING,
PHASE II SIZING PARAMERERS

**I7, V4(3), QP(14*), EROR, PZ(5), V9, SM(20),
**SY(28), SO(37,5), SE(11), TLAT, TLNG,
PHASE I SIZING PARAMERERS

**HB0, MLOO, DMEB, DMED, TDLWT, MPB, TWRAT2,
**BK1, BK2, BK3, BK4, ISIZE, TRAFLG, IWRAT0,
**EK1, BK2, OK3, OK4, PRFLG, IPASD, ISPB,
**OK1, OK2, OK3, OK4, PRFLG, IPASD, ISPB,
**OK1, TVACD, NO, MFO, IDVEL, ISPD, ISPB,
**PRL, TVACD, NO, MFO, IDVEL, ISPD, ISPB,
**PRL, TVACD, NNB, MEO, MEB, MO, MLO,
**DUO, DVB, MUB, MUD, VSTG, MPO
**JIYP, BECO, BSTG, DRBI, ITNBW, ITNDW,
**SVDPSQ, SVDCON, INUNT, IDPSTG, ISZD(14)
**OHMENSION SKBG3O),SCBG3OO,TB4(6), TB2G(16), TB27(6),TB34(6),
**I TB44G(10),TB49(10),TB50(10),TB57(6),BMSAVE(10)
**COMMON/GRBINY/
**I TB1, TB2, TB3, TB4, TB5, TB6, TB7, TB8, TB9, TB10,TB11,TB12,TB13,TB14,
**I TB1, TB2, TB3, TB4, TB5, TB6, TB7, TB8, TB9, TB10,TB11,TB12,TB13,TB34,TB37,TB36,TB37,TB38,TB39,TB40,
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**I TB1, TB2, TB3, TB4, TB5, TB6, TB7, TB7, TB7, TB7, TB7, TB80, TB91,TB50,TB51,TB52,TB53,
**I TB4, TB17, TB18, TB14, TB20, TB47, TB47, TB47, TB47, TB47, TB47, TB47, TB47,
**I TB41, TB42, TB44, TB45, TB46, TB47, TB48, TB47, TB50, TB51, TB52, TB53,
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                                                                                                                                                ORIVER SUBROUTINE FOR PHASE 2 DADS SIZING PROGRAM CALCULATES FLYBACK FUEL REQUIRED
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2CHBOBY CLBODY CSBODY
3CSPLAM CSVERT CSWING
4ISP(6) ITPS K(30)
5NENGS NLISTO NPASS
6RHOFUZ NHOX RHOXS
COMMON/VOLCAL/BBODY CROOT
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CSFAIR
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CSHORZ CSOXTK ,
OEF(5) FXMOVS ,
MR(6) NCREM ,
Q RHOFU ,
TOVERC TPRATO ,
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CSFUTK
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3SPLAN STPS(1) SVERT SWING
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4TIOT THOTZ THOTAL YOODYA
5VCREW VFUTK VFUTKZ WINSTK
6VOXTKZ VPROP STRUC
COMMON/WICALC/ ABFSYS WAEFO
1WACSTO WACSFO WACSTK WAEFO
2WBPUMP WCARGO WCOMM
3WDISTZ WDOCK WDPLOY WDRANS
5WFUZ(3) WFUEL(6) WFUL WFUTKZ
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,SOXTK
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WSTAB
WWAIT(10),
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SSSP
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                                   C
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                                                                                              FIRST PASS TEST
                                                                       IF( IPASS.EQ.1 ) GO TO 1
                                   CCC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              SSSP
SSSP
SSSP
                                                                                              ITERATION PASS
 128.
129.
130.
131.
                                                                       1F(1PASS.GT.IPSMAX) 60 TO 13
CALL READMS(3,SSPDAT,1699,1)
1F(5W(3).GT.SW(4)) 60 TO 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               UH
POW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        13
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               UH
 132.
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134
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POW
FINI
SSSP
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                                                       2 CALL OVERLAY(4MSSSP,7,4,6MRECALL)
18 IF( 10PSTG.GT.O ) 60 TO 15
CALL OVERLAY(4MSSSP,7,2,6MRECALL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        15
                                    CCC
                                                                                              CHECK CONVERGENCE OF SYNTHESIS LOOP
138.
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                                                      17 CONTINUE
IF( SW(2).LE.0.5) 60 TO 3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              POW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              POW
SSSP
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CKOUT
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                                                                                             CONVERGED VEHICLE CALL FOR ORBITER WEIGHTS
                                                             4 CALL OVERLAY(4HSSSP,7,2,6HRECALL)
CALL SUMOUT
                                    CCC
                                                                                            RESET FLAGS FOR NEXT CASE
                                                                       IPASS = 1
SW(2) = 0.5
```

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| DOTO 999 UNIT, 7,3,0) UNIT, 14,0) UNIT, 14 |
|--|
| UM UH UH UH UH UH UH UH UH UH UH UH UH UH |
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| |

222. C 223. C ERROR IN MITVOL SSSP SSSP SSSP SSSP 5 WRITE (6,998)
998 FORMAT (38M CASE ABORTED DUE TO ERROR IN WTVOL
12 TRAFLG=2.0.
CALL SIZERR 224. 225. 226. 227. UH UH 10 WRITE(6,11)
11 FORMAT(36H MAXIMUM ITERATIONS EXCEEDED IN SSSP 60 TO 12
13 WRITE(6,14)
14 FORMAT(27H IPASS GREATER THAN IPSMAX)
60 TO 12 228. 229. 230. UH UH UH 12-231. 232. 233. 234. C 235. C 236. C UH UH SSSP SSSP SSSP SSSP SSSP 12-RETURN TO PADS 999 RETURN END

20 OCT 72 6.01-46

BLØCK CINPUT

| パン |) | • |
|----|---|---|
| `\ | | |

| OHTRAN | MAIM | DESCRIPTION | STORA | | SJARCUILA | |
|---------------|--------|--|-----------|------|---|--------------------------------------|
| YMROL | SYMBOL | DESCRIPTION | HLULK | LOL | SUBA COO | E VAR |
| 1 | | Number of air breathing engines used by set0 to set common to zero | /CINPUT/(| 1) | FRENCH I
FRENCH M
SETO O
STORE M
WISCH I | A
ANENGS
A
ANENGS
ANENGS |
| NTANK | | Number of air breathing fuel tanks | /CINPUT/C | 2) | STORE M | ANTANK |
| SRATO | | Wing aspect ratio | /CINPUT/(| 3) | STORE M
WTSCH I | ASRATO
ASRATO |
| SWEEP | | Wing leading edge sweep angle | /CINPUT/(| 4) | STORE M
WTSCH I | ASWEEP
ASWEEP |
| | | Input array c(300) of vehicle sizing data | /CINPUT/(| 5) | PRINTW I
PRITEG I
PRITVA I
STORE M
WISCH I
WIVOL D | 000000 |
| BBODY | | Body width coeff. | /CINPUT/(| 305) | PRITVA I
STORE M
WTSCH I | CBBCDY
CBBCDY
CBBDDY |
| FUEL | | Mixture ratio | /CINPUT/(| 306) | PRWTSM M
STORE M
WTSCH M | CFUEL
CFUEL
CFUEL |
| H80 DY | | Body height or coeff | /CINPUT/(| 312) | PRITVA I
STORE M
WTSCH I | CHBODY
CHBODY
CHBODY |
| LBODY | | Body length or coeff | /CINPUT/(| 313) | PRITVA I
STORE M
WTSCH I | CLBODY
CLBODY |
| SBODY | 5 | Total body metted area or coeff | /CINPUT/(| 314) | PRITVA I
STORE M
WTSCH I | CSBODY
CSBODY
CSBODY |
| SFAIR | | Fairing planform area or coeff | /CINPUT/(| 315) | PRITVA I
STORE M
WTSCH I | CSFAIR
CSFAIR
CSFAIR |
| SFUT K | | Fuel tank surface area or coeff | /CIMPUT/(| 316) | PRITVA I
STORE M
WTSCH I | CSFUTK
CSFUTK
CSFUTK |
| SHORZ | - | Horizontal stabalizer planform area | /CINPUT/(| 317) | PRITVA I
STORE M
WISCH I | CSHORZ
CSHORZ
CSHORZ |
| SOXTK | | Oxidizer tank surface area coeff | /CINPUT/(| 318) | PRITVA I
STORE M
WISCH I | CSOXTE
CSOXTE
CSOXTE |
| SPLAN | | Body planform area or coeff | /CINPUT/(| 319) | PRITVA I
STORE M
WTSCH I | CSPLAN
CSPLAN
CSPLAN |
| SVERT | | Vertical fin planform area or coeff | /CINPUT/(| 320) | PRITVA I
STORE M
WTSCH I | CS VERT
CS VERT
CS VERT |
| WING | | Wing planform area | /CINPUT/(| 321) | STORE M | CSWING |
| THRST | | Vac. Thrust-to-weight ratio | /CINPUT/(| | PRITVA I
STORE M
WISCH I
WIVOL M | CTHRST
CTHRST
CTHRST
CTHRST |
| THST2 | | Secondary propulsion t/m | /CINPUT/(| 323) | PRITVA I
STORE M
WTSCH I | CTHST2
CTHST2
CTHST2 |
| xwo vs | | Fixed sing loading | /CINPUT/(| 329) | STORE M
WTSCH I | FXWOVS
FXWOVS |

| ORTRAN | | DESCRIPTION | | STORAGE | | F USAGE |
|-----------|--------|---|-----------|---------|---|----------------------------------|
| SYMBOL | SYMBOL | DESCRIPTION | BLOLK | LUC | 2034 COO | |
| ISP | | Specific impulse | /CINPUT/(| 330) | PRWTSM I
STORE M | ISP
ISP |
| 1 T P S | | Thermo protection flag | /CINPUT/(| 336) | WTSCH I
WTVOL O
FRENCH D | ISP
ISP
ITPS |
| | | • | | | STORE M
WTSCH M | TTPS
TTPS |
| K | | Description not input | /CINPUT/(| 337) | PRITED I
STORE M
MTSCH M | K
K |
| LF | | Ultimate load factor 1. Thrust buildup 2. Not used
3. Main impulse mass ratio 4. Main impulse reserve
5. Secondary impulse mass ratio 6. Not used | /CINPUT/(| 368) | STORE # UTSCH . I | LF
LF |
| MR | | Mass ratio | /CINPUT/(| 369) | PRWTSM I
SOLVE I
STORE M
WTSCH M | MR
MR
MR
MR |
| NCREW | | Number of crem members | /CINPUT/(| 375) | PRITVA I
STORE M
WTSCH I | NCREW
NCREW
NCREW |
| NENGS | | Total number engines per stage | /CINPUT/(| 376) | PRITVA I
STORE M
WTSCH I | NENGS
NENGS
NENGS |
| NLISTO | | Namelist output flag | /CINPUT/(| | STORE M
WTSCH I | NLISTO
NLISTO |
| NPASS | | Number of passengers | /CINPUT/(| | STORE M
WTSCH I | NPASS
NPASS |
| NWL | | Wing loading flag | /CIMPUT/(| 317) | FRENCH O
STORE M
WTSCH M | NWL
NWL |
| P C H A M | | Main rocket engine chamber pressure | /CINPUT/(| | STORE M
WTSCH I | PCHAM
PCHAM |
| 9 | | Maximum dynamic pressure | /CINPUT/(| | WTSCH M | 0 |
| RHOFU | • | Fuel density | /CINPUT/(| 382) | PRITVA I
STORE A
MISCH I | RHOFU
RHOFU
RHOFU |
| RHOFU2 | | Secondary fuel desnity | /CINPUT/(| 383) | PRITVA I
STORE M
WTSCH I | RHOFU2
RHOFU2
RHOFU2 |
| Х СНЯ | | Oxidizer density | /CINPUT/(| 384) | PRITVA I
STORE M
WTSCH I | X 6ня
Х 6ня
Х 6ня |
| RHOX2 | | Secondary oxidizer density | /CINPUT/(| 385) | PRITVA I
STORE A
WISCH I | RH0X2
RH0X2
RH0X2 |
| SBODY | | Total body metted area | /CINPUT/(| 386) | PROTHR I
TAMPER I
WISCH M | SBODY
SBODY
SBODY |
| TOL | | Gross meight iteration tolerance | /CINPUT/(| 387) | SOLVE M | TOL |
| TOVERC | | Wing thickness over choord ratio | /CINPUT/(| 388) | PROTHR I
STORE M
WTSCH I | TOVERC
TOVERC
TOVERC |
| TPRATO | | Wing taper ratio | /CINPUT/(| 389) | STORE M
WISCH I | TPRATO TPRATO |
| TYTAIL | | Description not input | /CINPUT/(| 390) | STORE M | TYTALL |
| V 8 0 D Y | | Total body volume | /CINPUT/(| 391) | PRINTY M
SOLVE M
STORE M
TAMPER I
UTSCH M | V800Y
V800Y
V800Y
V800Y |

| FORTHAN | MAIH | DESCRIPTION | STOR | 4 i E | SUBROUTINE
SUBB CODE | USA |
|---------|--------|-------------|-------|-------|-------------------------|-----|
| SYMBUL | SYMBOL | DESCUTLITON | BLOLK | LOC | SUSH CODE | VAF |
| | | | | | | |

WGROSS

Gross lift-off meight

/CINPUT/(392) PRINTW I WGROSS PRWTSM I WGROSS SOLVE M WGROSS STORE M WGROSS TAMPER I WGROSS WTVOL I WGROSS



BLØCK DATA2X

| ORIRAN | | SYMBOL DESCRIPTION | | 3E | SUBBO | | |
|----------------|--------|--|-------------|-----|----------------|---------|-----|
| SYMHOL | SYMBOL | DE JOHAN 110W | BLUIK | LOC | SUBR | COO | È ' |
| | | | | | | - | |
| ALO | | Baoster sub-sonic I/d | /DATA2X/(| 1) | SSSP | D | A |
| | | | | | VEHDF
VEHDF | FQ
I | A |
| BPAR | | Estimate of slope for booster cruise adjustment if | /DATAZX/(| 2) | VEHDF | I | FB |
| | | woreq 70 or wporeq 70 | | | | | |
| IDVEL | | Total ideal velocity estimate to parking orbit
insertion | /DATA2X/(| 3) | VEHDF | I | 10 |
| ISLB | | Booster sea level specific impulse | /DATA2X/(| 4) | | | |
| VACB | | Description not input | /DATA2X/(| | VEHDE | ı | 11 |
| VACD | | Description not input | /DATA2X/(| | VEHDE | 1 | 1 |
| SLO | | Orbiter sea level specific impulse | /DATA2X/(| | VEHDE | 1 | P |
| MXX | | Description not input | /DATA21/(| | VEHDE | ı | 01 |
| MXS | | Description not input | /DATA2X/(| | VEHDE | ı | 01 |
| SFC | | Description not input Description not input | /DATA2X/(| | VEHDE | i | Si |
| SLVOUT | | • | /DATA2X/(| | VEHDF | ı | SI |
| COPIES | | Description not input | /DATA2X/(| | VEHDE | ı | C |
| SYNIT | | Description not input Description not input | /DATA2X/(| | VEHDF | ı | S |
| VACB | | • | /DATA2X/(| | VEHDE | I | TI |
| FCTRO | | Booster bac. Isp | /DATA2X/(| | | I | Tí |
| TOLMU | | Description not input | /DATA2X/(| | VEHDF
VEHDF | 1 | T |
| | | Description not input | | | VEHDE | ı | T |
| OLTW | | Description not input | /DATAZX/(| | | - | |
| VACO | | Orbiter vac. Isp | /DATA2X/(| | VEHOF | I
, | T |
| WLO | | Description not input | /DATA2X/(| | VEHOF | 1 | 10 |
| WLOI | | Description not input | /DATA2X/(| | VEHDE | I . | T |
| TOUT | | Description not input | /DATA2X/(| | VEHDE | I
• | |
| TIRE | | Description not input | /DATA2X/(| | VEHDE | I
• | F |
| 300TW | | Description not input | /DATA2X/(| | VEHDE | I | В |
| CRUSE | | Description not Input | /DATA2X/(| | VEHOF | I | V |
| ERISP | | Booster effective isp estimating parameter | /DATA2X/(| | VEHDF | I | N |
| MAX | | Estimate of max q during ascent used for sizing vehicle | /DATA2X/(| 27) | | | |
| MXS | | Slope used for max-q adjustment when t/w i.o. Varies during synthesis iterations | /DATA2X/(| 28) | | | |
| FC | | Specific fuel consumption of booster air breathers | /DATA2X/(| 29) | VEHDE | i | C |
| LVOUT | | Output flag for sizing data | /DATA2X/(| 301 | VEHDE | I | D |
| OPIES | | Number of copies of summary sheet to be output | /DATA2X/(| 31) | VEHDE | 1 | Si |
| SYNIT | | Number of allowable synthesis iterat -ions (max = 6) | /DATA2X/(| 32) | VEHDF | 1 | A: |
| FCTRB | | Booster thrust multiplier for ascent | /DAT 42 X/(| 33) | VEHDE | i | B : |
| ISP | | Description not input | /DATA2X/(| 34) | VEHDE | I | 5 |
| INERT | | Description not input | /DATA2X/(| 35) | VEHDF | 1 | 5. |
| AE | | Description not input | /DATA2 X/(| 36) | VEHDF | I | 5 |
| FCTRO | | Orbiter thrust multiplier for ascent | /DATA2X/(| 37) | VEHDF | I | T |
| LYBCK | | Description not input | /DATA2X/(| 38) | VEHDE | 1 | F |
| IPORE 9 | | Description not input | /DATA2X/(| 39) | VEHDF | 1 | W |
| IOREO | | Description not input | /DATA2X/(| | VEHDE | | W(|
| WREG | | Description not input | /0ATA2X/(| 41) | VEHDE | I | G |
| BFUEL | | Description not input | /DATA2X/(| | VEHDF | | F |
| : A | | Description not input | /DATA2X/(| | VEHDE | | C |
| OLMU | | Orbiter wass ratio tolerance input | /DATA2X/(_ | | VEHDE | | C |
| OLTW | | Tolerance on two iteration | /DATAZX/(| | VEHDF | • | ㅂ |
| RATIO | | Ratio of booster to proliter engine thrust (vac) | /DATA2X/C | | VEHDF | | R |



| PORTHAN | | DESCRIPTION | STORAGE | | <u>SUAROUTINE</u> | | |
|---------|--------|--|-----------|------|-------------------|----------|---------------|
| SYMBOL | SYMBOL | DESCRIPTION | BLUCK | LOC | 2 U B H | coo | VAR |
| TWLO | | Desired value of 1.o. T/m | /DATA2X/(| 47) | VEHDF | 1 | R1 |
| TWLOI | | Maximum number of iterations to obtain twio | /DATA2X/(| | VEHDE | ī | R3 |
| WTOUT | | Dutput print flag | /DATA2X/(| | VEHDE | 1 | SECI |
| FIRE | | Ascent burn sequence flag 1= simultaneous stage burn 2= sequential stage burn | /DATA2X/(| | VEHDF | ī | SFC2 |
| SFC3 | | Description not input | /DATA2X/(| 51) | VEHDE | 1 | SFC3 |
| VCRUSE | | Booster flyback cruise velocity | /DATA21/(| 52) | VEHDE | I | ALD1 |
| NXFOB | | Fing for crossfeed of propellants from booster tanks to orbiter engines at lift-off lf fire =1 | /DATA2X/(| 53) | VEHDF | I | ALD2 |
| PRNTX | | Data/ print flag | /DATA2X/(| 54) | VEHOF | 1 | ALD3 |
| VFLY1 | | Description not input | /DATA2X/(| 55) | VEHDE | ı | VFLY1 |
| VFLY2 | | Description not input | /DATA2X/(| 56) | VEHDF | I | VFLY2 |
| VFLY3 | | Description not input | /DATAZX/(| 57) | VEHOF | 1 | VFLY3 |
| SOLID | | Number of solid motors also flag for solid motor option | /DATA2X/(| 58) | | | |
| AS | | Solid motor thrust curve intercept | /DATA2X/(| 59) | TNUH | 1 | RVAR |
| 85 | | Solid motor thrust slope | /DATA2X/(| 60) | HUNT | I | PNDX |
| SISP | | Solid motor vacuum isp | /DATA2X/(| 61) | | | |
| SINERT | | Solid motor inert weight | /DATA2X/(| 62) | | | |
| SAE | | Solid motor exit area | /DATA2X/(| 63) | • | | |
| TSBO | | Solid rocket burn time | /DATA2X/(| 64) | | | |
| FBFUEL | | Flyback cruise calculation flag 1= parametric range
data 2= staging- q function 3= constant range 4=
ballistic impact range 5= entry trajectory simulation | /DATA2X/(| 65) | | • | |
| CA | | Per cent booster weight for cruise back leg no. 1 | /DATA2X/(| 66) | | | |
| CB | | Per cent booster meight for cruise back leg no. 2 | /DATA2X/{ | 67) | | | |
| MFLYX | | Addative booster meight for flyback | /DATA2X/(| 68) | | | |
| RT | | Transition range increment for flyback calculations | /BATA2X/C | 693 | | | |
| R 1 | | Idle descent range increment for flyback calculations | /DATA2X/(| 79) | HUNT | 1 | 8 L0 ₩ |
| R 3 | | Final descent flyback range increunt | /DATA2X/(| 71) | | | |
| SFC1 | | Specific fuel consumption | /DATA2X/E | 72) | | | |
| SFC2 | | Specific fuel consumption | /DATA2X/(| 73) | | | |
| SFC3 | | Specific fuel consumption | /DATA2X/(| 74) | | | |
| ALD3 | | Booster sub-sonic I/d | /DATA2X/(| 77) | | | |
| BUPP | | Description not input | /DATA2X/(| 80) | HUNT | 1 | BUPP |
| STEP | | Description not Input | /DATA2X/(| 96) | HUNT
SSSP | PA
PA | STEP
STEP |
| PAYX | | Description not input | /DATA2X/(| 101) | HUNT | I | PAYX |
| VF LY 1 | | Booster flyback cruise velocity psel | /DATA2X/(| 78) | | | |
| VFLY2 | | Booster flyback cruise velocity pse2 | /DATA2X/(| 79) | | | |
| VFLY3 | • | Booster flyback cruise velocity pse3 | /DATA2X/(| 80) | | | |



BLØCK EMS



| FURTRAN | MATH
Symbol | DESCRIPTION | <u>5.1</u> | 0647
R | , F
L D C | SUAROUTIA
SUBR COO | |
|-------------|----------------|------------------------|------------|-----------|--------------|-----------------------|------------------|
| | ···· | | | | | | |
| MORBIT | | Weight in orbit | /EMS | /(| 1) | PRWISM O | WORBIT
Worbit |
| WETURN | | Weight at return point | /EMS | /(| 2) | PRWTSM O
TAMPER I | WETURN
WETURN |
| WENTRY | | Entry weight | /EMS | /(| 3) | PRWISM O
Tamper I | WENTRY
WENTRY |
| WLAND | • | Landing weight | /EMS | /(| 4) | PRWTSM O
Tamper I | WLAND
Wland |



BLØCK JUMPY



| FURTHAN
Symbol | MATH
Symbol | DESCRIPTION | STORAGE
Block Loc | SUBROUTINE USAGE
SUBR CODE VAR |
|-------------------|----------------|---------------------------------|----------------------|---|
| JUMP | | Data flag O= orbiter l= booster | /JUMP4 /(1) | FRENCH O JUMP PRINTW 1 JUMP PRITYA 1 JUMP PRWISM M JUMP WISCH 1 JUMP WIVOL M JUMP |
| wB00 | | Booster gross meight | /JUMPY /(3) | PRINTW I WBOO
TAMPER I WBOO
WTVOL O WBOO |



BLØCK ØRBINX

| | DESCRIPTION | <u> </u> | | SUARO | | |
|-----------|--|--------------------|------|---|----------------------------|--|
| SYMBOL SY | MADL DESCRIPTION | BLOCK | LOC | SUBA | LUD | <u>. </u> |
| *** | Character and the second of the control | | | | _ | • - |
| 702 | Stored orbiter value of choody | /ORBINX/(| | STORE | 19 | 10 |
| T04 | Stored orbiter value of cfuei(1) | /ORBINX/(| | STORE | A | TO |
| 105 | Stored orbiter value of choody | /ORBINX/(| | STORE | M | 10 |
| 106 | Stored orbiter value of cloody | /0ABINX/(| | STORE | 19 | 10 |
| 107 | Stored orbiter value of cabody | · /ORBINX/(| | STORE | R | 10 |
| 7010 | Stored orbiter value of cafair | /08B1NX/(| | STORE | /A | TO |
| 1011 | Stored orbiter value of csfutk | AORBINX/(| | STORE | M | 10 |
| 1012 | Stored orbiter value of csoxtk | /ORBINX/(| | STORE | M | TO |
| 1013 | Stored orbiter value of cshorz | /ORBINX/(| | STORE | M | TO |
| 1015 | Stored orbiter value of csplan | /ORBINX/(| | STORE | A | TO |
| 1016 | Stored orbiter value of cavert | /ORBINX/(| | STORE | M | 10 |
| 1017 | Stored orbiter value of caming | /ORBINX/(| | STORE | 19 | TO |
| 1018 | Stored orbiter value of cthrst | /ORBINX/(| 23) | STORE | Ħ | TO |
| 019 | Stored orbiter value of cthstz | /ORBINX/(| 24) | STORE | Ħ | TO |
| 7027 | Stored orbiter value of isp(i) | /DRB1 N X/(| 41) | SIZEMI
SSSP
STORE
SUMOUT
VEHDF
WTVOL | I | TO
TO
TO
TO |
| 034 | Stored orbiter value of mr(i) | /ORBINX/4 | 53) | ITER8 SSSP STORE TAMPEI VEHDF WIVOL | M
0
M
1
0
M | TO
TO
TO
TO |
| 035 | Stored orbiter value of ncrem | /ORBINX/(| 59) | STORE | Ħ | 10 |
| 036 | Stored orbiter value of nengs | /DRBINX/(| 60) | STORE
SUMOU'
TAMPEI
THRUS'
WTVOL | I | T()
T()
T() |
| 038 | Stored orbiter value of mpass | /ORBINX/(| 62) | STORE | m | Ti |
| 041 | Stored orbiter value of rhofu | /QRBINX/(| 65) | STORE | M | Ti |
| 042 | Stored orbiter value of rhofu2 | /ORBINX/(| 66) | STORE | Ħ | T |
| 043 | Stored orbiter value of rhox | /ORBINX/(| | STORE | æ | T |
| 044 | Description not input | /ORBINX/(| 68) | STORE | A | T |
| 045 | Stored orbiter value of swing | /ORBINX/(| 69) | STORE
SUMOUT | | T |
| 047 | Stored orbiter value of tovers | /ORBINX/(| 711 | STORE | · r4 | T |
| 051 | Stored orbiter value of vbody | /DRBINX/(| | STORE | A
O | T |
| 052 | Stored orbiter value of vfutk | /ORBINX/(| 103) | STORE | 0 | T |
| 053 | Stored orbiter value of vfutk2 | /ORBINX/(| 104) | STORE | A | Ţ |
| 754 | Stored orbiter value of voxtk | /ORBINX/(| 105) | STORE | 0 | Ţ |
| 055 | Stored orbiter value of voxtk2 | /ORBINX/(| | STORE | M | Ţ |
| 756 | Stored orbiter value of mgross | /DABINX/(| 107) | STORE | M
M | Ţ |
| KO | Working name for input k-array orbiter volume so | caling /ORBINX/(| 114) | STORE | M | 1 |
| KO | Description not input | /DRBINX/(| 115) | STORE | 19 | 5 |
| N U | | | | | | |

| FORTRAN | MATH | | DESCRIPTION | | | SURROU | | |
|---------|--------|-----------------|----------------|-----------|------|------------------------------------|-------------|-------------------------|
| SYMBOL | SYMBOL | | DESCRIPTION | BLOUK | LOC | SUBA | CODE | VAR |
| SCO | | Description not | Input | /ORBINX/(| 145) | STORE
TAMPER
THRUST
WTVOL | M
M
M | S C O
S C O
S C O |
| OWSAVE | | Description not | Input | /ORBINX/(| 445) | STORE
Tamper | | DWS AVE |
| 1059 | | Description not | Input | /ORBINX/(| 455) | STORE | M | T059 |
| T060 | | Description not | Input | /ORBINX/(| 456) | STORE | 19 | T060 |
| T061 | | Description not | input | /ORBINX/(| 457) | STORE | Ħ | T061 |
| 1062 | | Description not | Input | /ORBINX/(| 458) | STORE | M | T062 |
| T063 | | Description not | Input | /ORBINX/(| 459) | STORE | e | T063 |
| T064 | | Description not | Input | /ORBINX/(| 460) | STORE | M | T064 |
| T065 | | Description not | Input | /ORBINX/(| 461) | STORE | M | T065 |
| T067 | | Description not | Input | /ORBINX/(| 462) | STORE | M | T067 |
| T068 | | Description not | Input | /ORBINX/(| 463) | STORE | M | T068 |
| T069 | | Description not | input | /ORBINX/(| 464) | STORE | M | T069 |
| T070 | | Description not | Input | /ORBINX/(| 465) | STORE | M | T070 |
| T071 | | Description not | Input | /ORBINX/(| 466) | STORE | Ħ | T071 |
| T072 | | Description not | Input | /ORBINX/(| 467) | STORE | m | T072 |
| T073 | | Description not | input ' | /ORBINX/(| 468) | STORE | M | T073 |
| T074 | | Description not | Input | /ORBINX/(| 469) | STORE | m | T074 |
| T075 | | Description not | Input | /ORBINX/(| 470) | STORE | m | T075 |
| T076 | | Description not | input | /ORBINX/(| 471) | STORE | M | T076 |
| T077 | | Description not | input | /ORBINX/(| 472) | STORE | M | T077 |
| T078 | | Description not | Input | /ORBINX/(| 473) | STORE | M | T078 |
| T079 | | Description not | input | /ORBINX/(| 474) | STORE | Ħ | T079 |
| T080 | | Description not | Input | /ORBINX/(| 475) | STORE | M | T080 |
| T081 | | Description not | input | /ORBINX/(| 476) | STORE | M | T081 |
| T082 | | Description not | ▼ ⁻ |)\xnierg\ | 477) | STORE | m | T082 |
| 1083 | | Description not | • • | /ORBINX/(| 478) | STORE | A | T083 |
| T084 | | Description not | | /ORBINX/(| | STORE | | T084 |

BLØCK ØRBINY



| URTRAN
YMBOL | MAIH
Symbol | DESCRIPTION | STORA:
BLOCK | ιος
- | <u> 5 UBR D (</u>
5 UBR | | |
|-----------------|----------------|--|------------------------|----------|----------------------------|---------|-----|
| | | | | | | | |
| 1 | | Description not input | /0881NY/(| 1) | HUNT | M | A |
| | | Edward baselow walne of abbado | /0801NV // | 21 | SSSP | 1 | 55P |
| B2
B59 | | Stored booster value of cbbody Stored booster value of If | /ORBINY/(| | STORE. | M · | T82 |
| 84 | | Stored booster value of cfuel(1) | /ORBINY/(
/ORBINY/(| 4) | | " | רפו |
| 85 | | Stored booster value of chbody | /ORBINY/(| | STORE | M | 185 |
| B6 | | Stored booster value of cloody | /ORBINY/(| | STORE | A | TB6 |
| 87 | | Description not input | /ORBINY/(| | STORE | | 187 |
| 810 | | Stored booster value of csfair | /ORBINY/(| | STORE | m | TB1 |
| B11 | | Stored booster value of csfutk | /ORBINY/C | | STORE | M | TB1 |
| 812 | | Stored booster value of csouth | /ORBINY/(| | STORE | | TBI |
| 813 | | Stored booster value of cshorz | /ORBINY/C | | STORE | | TB1 |
| B15 | | Stored booster value of capian | /ORBINY/(| | STORE | | T81 |
| B16 | | Stored booster value of cavert | /ORBINY/(| | STORE | A | TB1 |
| B17 | | Stored booster value of csming | /ORBINY/(| | STORE | m | TBI |
| 818 | | Stored booster value of cthrat | /DRBINY/(| | STORE | 8 | TBI |
| | | •••••• | | | MTVOL | 0 | TBI |
| B19 | | Stored booster value of cthst2 | /ORBINY/(| 24) | STORE | M | TBI |
| B27 | | Stored booster value of isp(i) | /ORBINY/(| 41) | SIZEME | | TB2 |
| | | | | | SSSP
Store | I | TB2 |
| | | | | | SUMOUT | I | TB2 |
| | | | | | TAMPER
VEHDF | M | TB2 |
| | | | | | WTVOL | 1 | TB2 |
| B34 | | Stored booster value of mr(i) | /ORBINY/(| 53) | FLYBKP | | TB3 |
| | | | | | ITER8
SSSP | O
M | TB3 |
| | | | | | STORE | M | TB3 |
| | | | | | SUMOUT | | TB3 |
| | | | | ٠. | VEHDF | 1 | TB3 |
| | | | 400000444 | | MINDE | | TB3 |
| 835 | | Stored booster value of nerem | /08BINY/(| 1 | STORE | | 183 |
| B36 | | Stored booster value of nengs | /ORBINY/(| 60) | STORE
SUMOUT | ra
I | TB3 |
| | | | | | TAMPER | 1 | TB3 |
| | | | | | THRUST
WTVOL | I | TB3 |
| 838 | | Stored booster value of npass | /ORBINY/(| 62) | STORE | | TB3 |
| B41 | | Stored booster value of rhofu | /ORBINY/(| | STORE | M | TB4 |
| 842 | | Stored booster value of rhofu2 | /ORBINY/(| | STORE | | T84 |
| 843 | | Stored booster value of rhox | /ORBINY/(| | STORE | | TB4 |
| 844 | | Stored booster value of rhox2 | /ORBINY/ | | STORE | | TB4 |
| B45 | | Stored booster value of swing | /ORBINY/(| | STORE | | TB4 |
| | | | | | SUMBUT | 1 | TB4 |
| 0.47 | | Educad basedon water of Acres | /8051444 | 711 | TAMPER | | TB4 |
| B47 | | Stored booster value of tovers | /ORBINY/(| | STORE | | T84 |
| 851 | | Stored booster value of vbody | /0RB1NY/(| 102) | STORE | | TB5 |
| 851 | | Stored booster value of vfutk | /0R81NY/(| 103) | STORE | | 185 |
| 853 | | Stored booster value of vfutk2 | /ORBINY/(| | STORE | | 185 |
| B54 | | Stored booster value of voxtk | /ORBINY/(| | STORE | | TB5 |
| B55 | | Stored booster value of voxtk2 | /ORBINY/(| | STORE | | TBS |
| F 125 4 4 4 4 | | The state of the s | | , | | | |

30 OCT 72 6.01-46



| FURTRAN | MATH | DESCRIPTION | STORA | | | | E USAGE |
|---------|--------|---|------------|------|---|-------------|---|
| SYMBOL | SYMBOL | DESCRIFTION | BLULK | 195 | SUNN | COB | E VAR |
| SKB | | Working name for input k-array booster volume scaling coeff | /DR81NY/(| 114) | STORE | M | SKB |
| SCB | | Working name for input c-array booster scaling coefficients | /ORBINY/(| 144) | FLYBKP
STORE
SUMOUT
TAMPER
THRUST
VEHOF
WTVOL | M I I M I M | 5 C B
5 C B
5 C B
5 C B
5 C B
5 C B
5 C B |
| BUSAVE | | Description not input | /ORBINY/(| 444) | STORE | A | BWSAVE |
| T 859 | | Description not input | /ORBINY/(| 459) | STORE | A | T859 |
| TB60 | | Description not input | /ORBINY/(| 455) | STORE | Ħ | TB60 |
| T 8 6 1 | | Description not input | /ORBINY/(| 456) | STORE | Ħ | TB61 |
| T 862 | | Description not input | /0RB1.NY/(| 457) | STORE | M | TB62 |
| T B 6 3 | | Description not input | /ORBINY/(| 458) | STORE | M | TB63 |
| T B 6 4 | | Description not input | /ORBINY/(| 459} | STORE | M | TB64 |
| T 865 | | Description not input | /ORBINY/(| 460) | STORE | M | TB65 |
| T B 6 6 | | Description not input | /ORBINY/(| 461) | STORE | M | TB66 |
| T B 6 7 | | Description not input | /ORBINY/(| 462) | STORE | Ħ | 1867 |
| T B 6 B | | Description not input | /ORBINY/(| 463) | STORE | Ħ | T868 |
| TB69 | | Description not input | /ORBINY/(| 464) | STORE | Ħ | TB69 |
| TB70 | | Description not input | /ORBINY/(| 465) | STORE | Ħ | TB70 |
| T B 7 1 | | Description not input | /ORBINY/(| 466) | STORE | Ħ | TB71 |
| T 8 7 2 | | Description not input | /ORBINY/(| 467) | STORE | M | TB72 |
| TB73 | | Description not input | /ORBINY/(| 4681 | STORE | Ħ | TB73 |
| T B 7 4 | | Description not input | /ORBINY/(| 469) | STORE | M | TB74 |
| T B 7 5 | | Description not input | /ORBINY/(| 470) | STORE | Ħ | TB75 |
| TB76 | | Description not input | /ORBINY/(| 471) | STORE | M | TB76 |
| T 8 7 7 | | Description not input | /ORBINY/(| 472) | STORE | M | TB77 |
| 1878 | | Description not input | /ORBINY/C | 473) | STORE | M | T878 |
| T B 7 9 | | Description not input | /ORBINY/(| 474) | STORE | M | TB79 |
| T 880 | | Description not input | /ORBINY/(| 475) | STORE | M | TB80 |
| T 8 8 1 | | Description not imput | /ORBINY/(| 476) | STORE | M | TB81 |
| 1882 | | Description not input | /ORBINY/(| 477) | STORE | M | 1882 |
| T 883 | | Description not input | /ORBINY/(| 478) | STORE | M | TB83 |
| T 8 8 4 | | Description not input | /ORBINY/(| 479) | STORE | A | TB84 |



BLØCK PØ FORTRAN MATH SYMBOL DESCRIPTION SUBBRICOS VAR

MPRNT Description not input

MPRNT Description not input

MPRNT TVEHOF I MPRNT

BLOCK PRESET



| FUHTRAN
SYMBOL | MATH
Symbol | DESCRIPTION | STORA W | E SUBBROUTINE USAGE
LOC SUBBROUGE VAR |
|-------------------|----------------|-------------------------------|---------------------------|--|
| PRESET | | Description and dapus PRESETS | /PRESET/(1) SSSP (VEHOF) | |
| | | FOR DATA2X | | VEHOF I PRESET |



BLØCK SUMVW

| ORTRAN MATH | DESCRIPTION | STORA | | SUBBOUTING | |
|---------------------------|-------------------------------------|-----------|-------|--------------------------------|----------------------|
| SYMBOL SYMBOL | DE GWALL I TOW | BLOCK | LOC | SUBH COD | E VAI |
| 40 P | Orbit maneuvering propellant melght | /SUMVW /(| 1) | SUMOUT I | ₩0₽
₩0₽ |
| JABFUB | Booster flyback fuel required | /sumvw /(| 2) | SUMOUT 1
TAMPER M | WABF |
| FUOXB | Propellant wt. Less fpr -booster | /SUMVW /(| 3) | SUMOUT I
TAMPER M | WFU0 |
| DRYB | Stage dry weight - booster | /SUMVW /(| 43 | SUMOUT I
TAMPER O | WDRY
WDRY |
| GROSB | Booster gross meight | /SUMVW /(| 5) | SUMOUT I
TAMPER M | WGR0
WGR0 |
| ОТНВ | Misc. Weight — booster | /SUMVW /(| 6) | SUMOUT 1
TAMPER O | HTGW |
| FUTKB | Total volume of fuel tank - booster | /SUMVW /(| 7) | SUMOUT 1
TAMPER 0 | VFUT
VFUT |
| OXTKB | Booster oxidizer tank volume | /SUMVW /(| 8) | SUMOUT I
TAMPER O | VOXT |
| ОТНВ | Misc. Booster volume | /SUMVW /(| 9) | SUMOUT I
TAMPER O | VOTH |
| 800Y8 | Booster body volume | /SUMVW /(| 10) | SUMOUT I
TAMPER D | V800
V800 |
| ABFUB . | Volume of booster propeliant tanks | /SUMVW /(| 11) | TAMPER 0 | VABF |
| BODYB | Description not input | /SUMVW /(| _ 12) | SUMOUT I
Tamper o | L800 |
| BODYB | Total body metted area- booster | /SUMVW /(| 13) | SUMOUT I
TAMPER O | 5800
5800 |
| PLANB | Booster body planform arem | /SUMVW /(| 14) | SUMOUT I
TAMPER D | SPLA |
| OVRSB | Booster ming loading | /SUMV# /(| 15) | SUMOUT I
TAMPER O | MO VE |
| IPAYLO | Payload meight | /SUMVW /(| 16) | SSSP I
SUMOUT I
TAMPER M | WPAY
WPAY
WPAY |
| DRYO | Stage dry meight morbiter | /SJMVW /(| 17) | SUMBUT I
Tamper D | WDRY |
| 0 T HO | Misc. Weight - orbiter | /SUMVW /(| 18) | SUMOUT I
TAMPER O | 410M |
| ABFU0 | Orbiter flyback fuel required | /SUMVW /(| 19) | SUMOUT I
TAMPER M | WABF |
| FUTKO | Total volume of fuel tank - orbiter | /SUMVW /(| 20) | SUMOUT I
TAMPER O | VFUT
VFUT |
| OXTKO | Orbiter oxidizer tank volume | /SUMVW /(| 21) | SUMOUT I
TAMPER O | VOXT |
| CARGO | Volume of cargo | /SUMVW /(| 22) | SUMOUT I
TAMPER O | VCAR
VCAR |
| OTHO | Misc. Orbiter volume | /SUMVW /(| 231 | SUMOUT 1
TAMPER 0 | HTOV |
| BODYO | Orbiter body volume | /SUMVW /{ | 24) | SUMOUT I
TAMPER O | VB00 |
| .80DYO | Description not input | /SUMVW /(| 25) | SUMOUT I
TAMPER O | L800 |
| BODYO | Total body metted area- orbiter | /SUMVW /(| 26) | SUMOUT I
TAMPER O | 5800
5800 |
| PLANO | Orbiter body planform area | /SUMVW /(| 27) | SUMOUT I
TAMPER O | SPLA
SPLA |
| JO VRSO | Orbiter wing loading | /SUMVW /(| 28) | SUMDUT 1
TAMPER 0 | MO VR |
| PORBTO | In-orbit weight - orbiter | /SUMVW /(| 29) | SUMOUT I
TAMPER D | WORB |
| ORBTB
0 OCT 72 G.01-46 | In-orbit meight - booster | /SUMVW /(| 30) | TAMPER O | WORE |

| FORTRAN
Symbol | MATH
Symbol | DESCRIPTION | STORAGE
BLOCK LOC | SUBRICODE VAR |
|-------------------|----------------|--------------------------------------|----------------------|--------------------------------------|
| WRTRNO | | Entry weight- orbiter | /SUMVW /(31 |) SUMOUT 1 WATRNO
TAMPER O WATRNO |
| WRTRNB | | Entry meight- booster | /SUMVW /(32 | - |
| WENTRO | | Orbiter entry weight | /\$UMVW /(33 | SUMOUT I WENTRO
TAMPER O WENTRO |
| WENTRB | | Booster entry meight | /SUMVW /(34 | SUMOUT I WENTRB |
| WLANDB | | Landing seight - booster | /SUMVW /(35 | SUMDUT I WLANDS
TAMPER O WLANDS |
| WLANDO | | Landing weight - orbiter | /SUMVW /(36 | SUMOUT I WLANDO
TAMPER D WLANDO |
| WCONTO | | Contingency and growth weight-orbite | /SUMVW /(37 | SUMOUT I WCONTO
TAMPER O WCONTO |
| WCONTB | | Contingency and growth weight-boostr | /SUMVW /(38 | SUMOUT I WCONTB
TAMPER Q WCONTB |



BLØCK TAMP

| FORTHAN
SYMBOI | MAIH
Symhol | DESCRIPTION | <u>- 5.1.0</u>
81.00K |) ii A (s | r
LOC | รูบคลอบ
รับษ์ค | | USAGE
VAR |
|-------------------|----------------|----------------------------------|--------------------------|-----------|----------|---------------------------|--------|----------------------------|
| WGROSO | | Orbiter grass weight | /TAMP | /(| 1) | SSSP
SUMOUT
WIVOL | I
I | WGROSO
WGROSO
WGROSO |
| 01101 | | Total orbiter thrust | / T A M P | /(| 2) | SUMOUT
TAMPER
WTVOL | | 01101
01101
01101 |
| WF UO XO | | Propellant mt. Less for -orbiter | /TAMP | /(| 3) | SUMOUT
TAMPER
WTVOL | | WFU0X0
WFU0X0
WFU0X0 |
| TBTO | | Description not input | /TAMP | /(| 4) | WTVOL | M | TBTO |
| BTTOT | | Total booster weight flow | /TAMP | /(| 5) | SUMOUT
TAMPER
WTVOL | | BTTOT
BTTOT
BTTOT |

BLØCK TRUST

| 12 | • |
|----|---|
| 69 | |
| 9 | |
| _ | |

| FORTRAN
SYMBOL | MATH
Symbol | DESCRIPTION | STOR | AGE
LOC | SUBROUTINE
SUBR CODE | US AGE |
|-------------------|----------------|-------------|------|------------|-------------------------|--------|
| | | | | | | |

FVACO

Orbiter vacuum thrust (1b)

/THRST /(1)

| FORTHAN
Symbol | MATH
Symbol | DESCRIPTION | | DRAS | COC. | <u>508800</u>
5088 | | E VAR |
|-------------------|----------------|--------------------------------------|--------|------|------|-----------------------|--------|----------------|
| | | | | | | | | |
| FVACO | | Description not input | /TAUST | /(| 1) | THRUST
WTSCH | M
I | FVACO
FVACO |
| FSLO | | Orbiter sea level thrust (1b) | /TRUST | /(| 2) | THRUST | M | FSLO |
| FVACLO | | Total vacuum lift-off thrust (16) | /TRUST | /(| 3) | THRUST | M | FVACLO |
| FVACS | | Solid motor total vacuum thrust (16) | /TRUST | /(| 4) | THRUST | A | FVACS |
| FVACB | | Booster vacuum thrust (16) | /TRUST | /(| 5) | THRUST
WTSCH | | FVACB
FVACB |
| FSLB | | Booster sea level thrust (lb) | /TRUST | /(| 6) | THRUST | M | FSLB |
| FSLLO | | Sea level lift-off thrust (1b) | /TRUST | /(| 7) | THRUST | rs. | FSLLO |
| FSLS | | Solid motor sea level thrust (16) | /TRUST | /(| 8) | THRUST | M | FSLS |



BLØCK VØLCAL

| ORTRAN | MATH | DESCRIPTION | S10AA | SUBBOUTIN | | |
|-----------|--------|--|------------|-----------|--|----------------------------------|
| SYMBOL | SYMBOL | OCJUNITION | BLOCK | LOC | SUAR COU | E VAR |
| DDDDU | | The state of the s | 440.00.44 | | | 00504 |
| 8800Y | | Body width used by setO to set common to zero | /VOLCAL/(| 1) | PROTHR I
Seto o | BBODY
D |
| | | | | | WTSCH M | 8800Y |
| CROOT | | Ing root chord | /VOLCAL/(| 2) | PROTHR I
WTSCH M | CROOT |
| CSPAN | | Structural span along 0.5 chord | /VOLCAL/(| 3) | PROTHR I
WTSCH M | CSPAN
CSPAN |
| CTIP | | Wing tip chord | /VOLCAL/(| 4) | WTSCH 0 | CTIP |
| GAL | | Total gallons of fuel | /VOLCAL/(| 5) | WTSCH M | GAL |
| GSPAN | | Geometric ming span | /WOLCAL/(| 6) | WTSCH M | GSPAN |
| HBODY | | Body height | /VOLCAL/(| 7) | PROTHR I | HBODY |
| LBODY | | Badw lanath | /VOLCAL // | ٥, | WTSCH 0
Prothr i | HBODY
LBODY |
| LBUUY | | Body length | /VOLCAL/(| 0, | TAMPER I
WTSCH M | LBODY |
| RTOD | | Deg to rad conversion | /VOLCAL/(| 9) | WTSCH M | RTOD |
| SFAIR | | Total fairing or shroud surface area | /VOLCAL/(| 10) | WTSCH M | SFAIR |
| SFUTK | | Total fuel tank metted area | /VOLCAL/(| 11) | PROTHR I
WTSCH M | SFUTK
SFUTK |
| SHORZ | | Horizontal stabilizer planform area | /VOLCAL/(| 12) | PROTHR I
WTSCH M | SHORZ
Shorz |
| SOXTK | | Total oxidizer tank metted area | /VOLCAL/(| 13) | PROTHR I
WTSCH M | SOXTK
SOXTK |
| SPLAN | | Body planform area | /VOLCAL/(| 14) | PROTHR I
TAMPER I
WTSCH O
WTVOL I | SPLAN
SPLAN
SPLAN
SPLAN |
| STPS | | Total thermal protection system surface area | /VOLCAL/(| 15) | WTSCH M | STPS |
| SVERT | | Vertical fin planform area | /VOLCAL/(| | PROTHR I
WTSCH M | SVERT
SVERT |
| Swing | | Gross wing area | /VOLCAL/(| 17) | PROTHR I
STORE M
WTSCH M | SWING
SWING
SWING |
| SXPOS | | Exposed sing area | /VOLCAL/(| 18) | PROTHR I
WTSCH 0 | SXPOS
SXPOS |
| TOEL | | Gimbal system delivered torque | /VOLCAL/(| 19) | MTSCH # | TDEL |
| TROOT | | Theoritical root thickness | /VOLCAL/(| 20) | WTSCH M | TROOT |
| T T O T | | Total stage vac. Thrust | /VOLCAL/(| 21) | PRITVA I
STORE I
WTSCH M
WTVOL I | TTOT
TTOT
TTOT
TTOT |
| TT0T2 | | Total stage vac. Secondary thrust | /VOLCAL/(| 22) | PRITVA I
WTSCH M | TT0T2
TT0T2 |
| FTOTAL | | Total stage vac. Thrust / 1,000,000 | /VOLCAL/(| 23) | WTSCH 0 | TTOTAL |
| VBODYA | | Total body volume less structure | /VOLCAL/(| 24) | WTSCH M | VBODYA |
| VB00Y1 | | Vbody to - 1/3 power | /VOLCAL/(| 25) | WTSCH M
WTVOL M | VBODY1 |
| /BODY2 | | Voody to - 2/3 power | /VOLCAL/(| 26) | WTSCH M
WTVOL M | V80DY2
V80DY2 |
| VCARGO | | Volume of cargo bay | /VOLCAL/(| 27) | PRINTY I
TAMPER I
WTSCH M | VCARGO
VCARGO
VCARGO |
| VCREW | | Volume of crem compartment | /VOLCAL/(| 28) | PRINTY I
WTSCH M | VCREW
VCREW |
| VFUTK
 | | Total volume of fuel tank | /VOLCAL/(| 29) | PRINTY I
STORE M
TAMPER I
WTSCH M | VFUTK
VFUTK
VFUTK
VFUTK |

| FORTHAN
Symbol | MATH
Symbol | DESCRIPTION | STORAGE
BLOCK | SURROUTINE USAG
LOC SUBA CODE VAR |
|-------------------|----------------|---|------------------|--|
| VFUTK2 | | Total volume of secondary fuel tank | /VOLCAL/(| 30) PRINTV I VFUTK
STORE M VFUTK
TAMPER I VFUTK
WTSCH M VFUTK |
| VINSTK | | Total tank insulation volume | /VOLCAL/(| 31) PRINTY I VINST
WTSCH M VINST |
| VLGBAY | | Valume of recovery system bay | /VOLCAL/(| 32) PRINTV I VLGBA
WTSCH M VLGBA |
| VOTHER | | Misc. And unused volume | /VOLCAL/(| 32) |
| VOTHER | | Description not input | /VOLCAL/(| 33) PRINTY I VOTHE
WTSCH M VOTHE |
| VOXTK | • | Total volume of oxidizer tank | /VOLCAL/(| 34) PRINTV I VOXTM
STORE M VOXTM
TAMPER I VOXTM
WTSCH M VOXTM |
| VOXTK2 | | Total volume of secondary oxidizer tank | /VOLCAL/(| 35) PRINTV I VOXTK
STORE M VOXTK
TAMPER I VOXTK
WTSCH M VOXTK |
| VPROP | | Volume of propulsion bay | /VDLCAL/(| 36) PRINTY I VPROP
WTSCH M VPROP |
| VSTRUC | | Volume of basic structure | /VOLCAL/(_ | 37) PRINTV I VSTRU
WTSCH M VSTRU |



BLØCK WTCALC



| FORTRAN | MATH | DESCRIPTION | STORAGE | | SUBROUTINE USA | |
|----------|--------|--|-----------|-----|---|------------------|
| SYMBOL | SYMBOL | DESCRIFTION | BLOCK | COC | SUBH CO | UE VAR |
| С | | Airbreathing fuel system weight used by set0 to set common to zero | /WTCALC/(| 1) | SETO C | |
| MABFTK | | Weight of air breathing propulsion system tanks | /WTCALC/(| 2) | PRINTW I | WABFT |
| JABF U | | Weight of jp fuel . | /WTCALC/(| 3) | PRINTW I
PRWTSM P
TAMPER I
WTSCH M | WABFL
Wabfl |
| JABPR | | Weight of air breathing engines | /WTCALE/(| 4) | PRINTM 1 | |
| JACRES | | Weight of attitude control fuel reserve | /WTCALC/(| \$) | PRINTW I
STORE P
WTSCH P | WACRE |
| MACS | | Weight of attitude control system. | /WTCALC/(| 6) | PRINTW I | |
| JACSF0 | | Weight of attitude control fuel plus oxidizer | /WTCALC/(| 7) | PRINTW I
STORE M
WTSCH P | WACSF |
| JACSTK | ĺ | Weight of attitude control tankage | /WTCALC/(| 8) | PRINTW I | |
| MAERO | | Weight of aerodynamic controls | /WTCALC/(| 9) | PRINTW I | |
| TXUAL | | Weight of separation system | /WTCALC/(| 10) | PRINTW I
STORE I
WISCH # | WAUXT |
| IBAS I C | | Total weight of basic body | /WTCALC/(| 11) | PRINTW I
PROTHR I
WTSCH M | WBAS |
| #B00Y | | Total meight of body group | /WTCALC/(| 12) | PRINTW I | |
| IBPUMP | | Weight of boost and transfer pumps | /WTCALC/(| 13) | WTSCH M | WBPU |
| ICAR GO | | Pavioad weight or cargo | /WTCALC/(| 14) | PRINTW I | |
| JCOMM | | Communication system weight | /WTCALC/(| 15) | PRINTW I | |
| ICONT | | Contingency and growth weight | /WTCALC/(| 16) | PRINTH I
TAMPER I
MTSCH M | |
| COVER | | Total weight of thermal protection system cover panels | /WTCALC/(| 17) | PRINTW I | #C0 46
#C0 46 |
| BDECAY | | Thrust decay propellant meight | /WTCALC/(| 18) | PRINTW I
STORE M
WISCH M | |
| DISTI | | Fuel system distribution meight ptl | /WTCALC/(| 19) | WTSCH M | WDIS1 |
| IDIST2 | | Fuel system distribution weight pt2 | /WTCALC/(| 20) | WTSCH # | ₩D151 |
| DOCK | | Docking structure weight | /WTCALC/(| 21) | PRINTW I | |
| JOPLOY | | Deployable aerodynamic device meight | /WTCALC/(| 22) | PRINTW I | |
| DRANS | | Fuel tank dump and drain weight | /WTCALC/(| 23) | WISCH # | WORA |
| IORY | | Stage dry weight | /WTCALC/(| 24) | PRINTW I
TAMPER I
WTSCH M | WDRY |
| IELCAD | | Description not input | /WTCALC/(| 25) | PRINTW I | WELC |
| FULLA | | Stage empty meight | /WTCALC/(| 26) | WTSCH M | WEMPT |
| JENGMT | | Engine mount weight | /WTCALC/(| 27) | MTSCH M | WENG |
| JENGS - | - | Weight of rocket engines installed | /WTCALC/(| 28) | PRINTW I | WENG: |

30 OCT 72 G.01-46

| UNIKAN
SYMBOL | MAIH
Symbol | DESCRIPTION | STORA:
BLOCK | FOC | SUBROUTIA
SUBR COD | |
|------------------|----------------|---|-----------------|-----|--|----------------------------------|
| WENGS2 | | Weight of secondary engines | /WTCALC/(| 29) | PRINTW I
WTSCH M | WENGS2
WENGS2 |
| WFAIR | | Weight of fairings and shrouds | /WTCALC/(| 30) | PRINTW I
WTSCH M | WFAIR
WFAIR |
| WFCONT | | Fuel system controls meight | /WTCALC/(| 31) | WTSCH M | WECONT |
| WFDCAY | | Thrust decay fuel meight | /WTCALC/(| 32) | WTSCH M | WFDCAY |
| WFROST | | Frost and ice weight | /WTCALC/(| 33) | PRINTW I
STORE M
WTSCH M | WFROST
WFROST
WFROST |
| WFU2 | | Weight of secondary fuel | /WTCALC/(| 34) | PRINTW I
TAMPER I
WTSCH M | WF U2
WF U2
WF U2 |
| WFUEL | | Fuel weight 1. Thrust build-up fuel 2. Not used 3.
Main impulse fuel wt. 4. Main impulse fuel reserve
5. Secondary impulse fuel 6. Not used | /WTCALC/(| 37) | PRWTS# M
WTSCH M | WFUEL |
| MFUL | | Fuel meight | /WTCALC/(| 43) | PRINTW I | WFUL |
| ⊎FULOS | | Vented fue! | /WTCALC/(| 44) | PRINTW I
STORE M
WTSCH M | WFULOS
WFULOS
WFULOS |
| MFUNCT | | Fuel tank meight | /WTCALC/(| 45) | WTSCH M | WFUNCT |
| MFUOX | • | Weight of main and secondary propellant | /WTCALC/(| 46) | PRINTW I
TAMPER I
WTSCH M
WTVOL I | WFU0X
WFU0X
WFU0X
WFU0X |
| MFURES | | Fuel reserve | /WTCALC/(| 47) | PRINTW I
STORE M
TAMPER I
WTSCH M | WFURES
WFURES
WFURES |
| WFUSYS | | Total fuel system meight | /WTCALC/(| 48) | PRINTW I
WTSCH M | WFUSYS
WFUSYS |
| WFUTK | - | Wt of non-structural fuel tankage | /WTCALE/(| 49) | PRINTW I
WISCH M | WFUTK
WFUTK |
| WFUTK2 | | Wt of secondary fuel tank and system | /WTCALC/(| 50) | PRINTW I
WTSCH M | WFUTK2
WFUTK2 |
| WFUTOT | | Total meight of fuel | /WTCALC/(| 51) | WTSCH M | WFUTOT |
| HFUTAP | | Trapped fuel meight | /WTCALC/(| 52) | PRINTW I
STORE M
WTSCH M | WFUTRP
WFUTRP |
| ⊭GASPR | | Weight of gas and pressurant | /WTCALC/(| 53) | PRINTW I
STORE M
WISCH M | WGASPR
WGASPR
WGASPR |
| HGNAV | | Guidance and navigation system mt | /WTCALC/(| 54) | PRINTW I
WTSCH M | WGNAV |
| WHOR1Z | | Horizontal stabilizer ut. | /WTCALC/(| 55) | PRINTW I
PROTHR I
WTSCH M | WHORZ
WHORZ
WHORZ |
| HHYCAD | | Hydraulic / pneumatic system et | /WTCALC/(| 56) | PRINTW I
WTSCH M | WHY CAD |
| MINFUT | | Weight of intergral fuel tank | /WTCALC/(| 57) | PRINTW I
PROTHR I
WTSCH M | WINFUT
WINFUT
WINFUT |
| TXGNI | | Weight of integral oxidizer tank | /WTCALC/(| 58) | PRINTW I
PROTHR I
WTSCH M | TKONIW
TKONIW
TKONIW |
| WINSTK | | Total meight of tank insulation | /WTCALC/(| 59) | PRINTW I
WISCH M | WINSTK
WINSTK |
| WINST | | | /WTCALC/(| 60) | PRINTU I
WTSCH M | WINST
WINST |
| WINSUL | | Description not input | /WTCALC/(| 61) | PRINTW I
WTSCH M | WÎNSUL
Winsul |

| URIRAN MATH | DESCRIPTION | STURA | | SUBFRUITA | |
|---------------|---|-------------|-----|--|-----------------------------------|
| SYMBOL SYMBOL | DESCRIPTION | BLOCK | LÜÜ | SUBH COU | E VAR |
| WJET | Jettison weight 1. Ignition to lift-off 2. Not used 3. Jettison during ascent 4. In-orbit jettison mt. 5. Pre-entry jettison mt. 6. Fly-back jettison mt. | /WTCALC/(| 62) | PRITVA I
PRWTSM M
STORE O
TAMPER I
WTSCH M | #15T
T3LW
T3LW
T3LW |
| WLANCH | Launch gear meight | /WTCALC/(| 68) | PRINTW I
WTSCH M | WLANCH
WLANCH |
| Mre | Landing gear and controls meight | /WTCALC/(| 69) | PRINTW I
WTSCH M | MF.e
MF.e |
| WLOSS | In-flight weight loss | /WTCALC/(| 70) | PRINTW I
PRWTSM I
WTSCH 0 | WL055
WL055
WL055 |
| MLAD | Launch and recovery system meight | /WTCALC/(| 71) | PRINTW I WTSCH M | WLRD
WLRD |
| WNACEL | Pylons, naceł, and pod weights | /WTCALC/(| 72) | PRINTW I
WTSCH M | WNACEL
WNACEL |
| ODCAY | Oxidizer thrust decay meight | /WTCALC/(| 73) | WTSCH M | WODCAY |
| MOIL | Service item losses | /WTCALC/(| | PRINTW I
WTSCH M | MOIL |
| MOILRS | Service item reserves | /WTCALC/(| | PRINTW I
WTSCH M | WOILRS
WOILRS |
| JORSUL | Orientation, control, and separation system meight | /WTCALC/(| | PRINTW I
WTSCH M | WORSUL
Worsul |
| JOVERS | Wing loading | /WTCALC/(| 77) | PROTHR I
Tamper I
WTSCH M | WOVERS
WOVERS
WOVERS |
| ₩ 0 X | Thrust build-up oxidizer 1. Thrust build-up oxidizer 2. Not used 3. Main impulse oxidizer 4. Main impulse oxidizer 4. Main oxidizer reserve 5. Secondary impulse oxidizer 6. Not used | /WTCALC/(| 78) | PRWTSM M
WTSCH M | MO X |
| ₩0 x 2 | Secondary oxidizer meight | /WTCALC/(| 84) | PRINTW I
TAMPER I
WTSCH M | ₩0 X2
₩0 X2
₩0 X2 |
| DIXO | Main impulse oxidizer meighter | /WTCALC/(| 87) | PRINTW I
WTSCH M | OIX CM |
| MOXLOS | Vented oxidizer | /WTCALC/(| 88) | PRINTW 1
STORE M
WTSCH M | WOXLOS
WOXLOS
WOXLOS |
| JO XRES | Oxidizer reserve | /WTCALC/(| 89) | PRINTW I
STORE M
TAMPER I
WTSCH M | WOXRES WOXRES WOXRES WOXRES |
| NO XSYS | Oxidizer system meight | /WTCALC/(| 90) | PRINTW I
WTSCH M | 2YZXGW
2YZXGW |
| 40 X T K | Non-sturctural tank et oxidizer | /WTCALC/(| 91) | PRINTW I
WTSCH M | MOXTK
Woxtk |
| JOXTK2 | Secondary system oxidizer tank mt | /WTCALC/(| 92) | PRINTW I
WTSCH M | MOXTK2 |
| TOTXOL | Total weight of oxidizer | /WTCALC/(| 93) | WTSCH M | TOTXOW |
| MO XTRP | Trapped oxidizer weight | /WTCALC/(| 94) | PRINTW I
STORE M
WTSCH M | ARTXOM
ARTXOM
ARTXOM |
| ⊌P | Total propellant weight | /WTCALC/(| 95) | MTSCH M | WP |
| WP ASS | Weight of passengers | /WTCALC/(| 96) | PRINTW I
WTSCH M | WPASS
WPASS |
| JP AYL | Payload meight | /WTCALC/(| 97) | PRINTW I
TAMPER I
WTSCH M | WPAYL
WPAYL
WPAYL |
| #PERS | Crew gear and life support weight | "/WTCALC/(" | 98) | PRINTW 1
WTSCH M | WPERS WPERS |

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| OHTHAN
SYMBOL | MATH
Symbol | DESCRIPTION | STORAG
BLUCK | LOC | SUBROUTING
SUBR CODE | |
|------------------|----------------|--|-----------------|------|--|----------------------------------|
| WPOWCD | | Power conditioning equipment wt. | /WTCALC/(| 99) | PRINTW I
WTSCH M | MPOMC |
| WPOWER | | Description not input | /WTCALC/(, | 100) | PRINTW I
WTSCH M | WPOWE |
| MPOWFO | | Power system propellant mt. | /WTCALC/(| 101) | PRINTW I
STORE M
WTSCH M | WPOWF |
| JPOWRS | | Power system propellant reserve | /WTCALE/(| 102) | PRINTW I
STORE M
WTSCH M | WPOWR
WPOWR
WPOWR |
| POWTK | | Prime power system tank weight | /WTCALE/(| 103) | PRINTW I
WTSCH M | WPOWT |
| PPROV | | Personnel provisions | /WTCALC/(| 104) | PRINTW J
WTSCH M | WPPRD
WPPRD |
| JPREIG | | Pre-ignition losses | /WTCALC/(| 105) | PRINTW I
PRWTSM M
WTSCH M | WPREI
WPREI
WPREI |
| IPROP | | Total meight- propulsion group | /WTCALC/(| 106) | PRINTW I
WTSCH M | WPROP |
| IPRSYS | | Pressurization system meight | /WTCALC/(| 107) | PRINTU I
WTSCH M | WPRSY
WPRSY |
| IREFUL | | Fuel system refueling system meight | /WTCALC/(| 108) | WTSCH M | WREFU |
| RESID | | Weight of residuals | /WTCALC/(| 109) | PRINTW I
WTSCH M | WRESI
WRESI |
| IRESRV | | Propellant reservs | /WTCALC/(| 110) | PRINTU I
WTSCH M | WRESR
WRESR |
| ISEAL | | Fuel tank seal weight | /WTCALC/(| 111) | WTSCH M | WSEAL |
| ISECST | | Secondary body structure mt | /WTCALC/(| 112) | PRINTU I
PROTHR I
WTSCH M | WSECS
WSECS |
| SORCE | | Prime power system weight | /WTCALC/(| 113) | PRINTW I | WSORC
WSORC |
| ISRTRP | | Trapped oxidizer weight | /WTCALC/(| 114) | PRINTW I
STORE M
WTSCH M | WSRTR
WSRTR
WSRTR |
| ISTAB | | Engine gimbal system #t | /WTCALC/(| 115) | PRINTW I
WTSCH M | WSTAB
WSTAB |
| SURF | | Aero surface at | /WTCALC/(| 116) | PRINTW I
WTSCH M | WSURF
WSURF |
| JTABC | | Net stage meight | /WTCALC/(| 117) | WTSCH 0 | WTABC |
| #THRST | | Thrust structure mt | /WTCALC/(| 118) | PRINTW I
WTSCH M | WTHRS
WTHRS |
| 10 | | Take- off meight | /WTCALC/(| 119) | PRINTW I
WTSCH M | OTW
GTW |
| ITPS | | Induced environmental protection mt | /WTCALC/(| 120) | PRINTW I
WTSCH M | WTP5
WTP5 |
| JVERT | | Vertical fin weight | /WTCALC/(| 121) | PRINTW I
PROTHR I
WTSCH M | WVERT
WVERT
WVERT |
| TIAWIT | | Summary meights 1. Ignition 2. Take-off 3. Burnout
4. Initial orbiter 5. Initial entry 6. Initial
flyback 7. Landing | /WTCALC/(| 122) | PRITVA I
PRWTSM I
STORE M
TAMPER I
WTSCH M | TIAWW
TIAWW
TIAWW
TIAWW |
| MET | | Operating meight-empty | /WTCALC/(| 132) | PRINTW I | WWET
WWET |
|
 | | Total structural mtOf ming | /WTCALC/(_ | | PRINTW_I = | MMI WG
MMI WG |
| JZROFU | | Zero fuel meight of vehicle | /WTCALC/(| 1341 | WTSCH M | WZROF |

SUBRØUT I NE DATA I N



| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAGE
Block Lo | SUBROUTINE USAGE
IC SUBR CODE VAR |
|-------------------|----------------|--------------------------|--|---------------------|--------------------------------------|
| FRENCH | | S Subroutine | to initialize vehicle sizing data | /FRENCH/(\$ |) DATAIN S FRENCH
FRENCH E FRENCH |
| THRUST | | S Subroutine vehicle thr | to determine booster, orbiter, and ust | /THRUST/(\$ |) DATAIN S THRUST
THRUST E THRUST |
| VEHDF | | S Subroutine | to call and initialize synthesis data | /VEHDF /(\$ |) DATAIN S VEHDF
VEHDF E YEHDF |

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PROGRAM DATAIN
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                                                                                                                     , LUM
, ID( 9)
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RETAP
DATAIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                       1PFLG2, 1PFLG3, 1PFLG4, INEQFL(20)
                                                                                                             *ITPSO KSOL , KGLOBLES)*
COMMON/JUMPY/ JUMP, WBIG, MBOO

REAL KIN
REAL ISP, K.LF, MR, NCREW, LBOOY, NPASS
REAL NENGS
COMMON/CIMPUT/
IANENGS , ANTANK , ASRATO , ASWEEP , C(300) , C8BODY , CFUEL(6),
2CHBOOY , CLBODY , CSBOOY , CSFAIR , CSFUTK , CSHORZ , CSOXTK ,
3CSPLAN , CSVERT , CSWING , CTHRST , CTHST2 , DEF(5) , FAWOYS ,
4ISP(6) , ITPS , K(30) , KIN , LF , MR(6) , NCREW ,
5NENGS , NLISTO , NPASS , NWL , PCHAM , Q , RNOFU ,
5NENGS , NLISTO , NPASS , NWL , PCHAM , Q , RNOFU ,
7TYTAIL , VBODY , MGROSS
DIMENSION SKO(30), SCO(300), TO4(6), TO20(10), TO27(6), TO34(6),
17048(10), T049(10), T050(10), T057(6), DWSAVE(10)
COMMON/ORBINX/
1 T01102, T03, T04, T05, T06, T07, T08, T09, T010, T011, T012, T013, T014,
2 T015, T016, T017, T018, T019, T020, T021, T022, T023, T024, T025, T026, T027,
3 T028, T029, T030, T031, T032, T033, T034, T035, T036, T039, T039, T040,
4 T041, T042, T043, T044, T045, T046, T047, T048, T049, T050, T051, T052, T053,
5 T054, T055, T056, T057, T066, SKO, SCO, OWSAVE
6, T059, T060, T061, T062, T063, T044, T045, T048, T049, T050, T051, T052, T053,
7 T072, T073, T074, T075, T076, T077, T078, T079, T080, T081, T082, T083,
8T084
BIMENSION SKB(30), SCB(300), TB4(6), TB20(10), TB27(6), TB34(6),
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ORBINX
CKOUT
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                                                                                                         6.1059, T060, T061, T062, T063, T064, T065, T067, T068, T069, T070, T071, T072, T073, T074, T075, T076, T077, T078, T079, T080, T081, T082, T083, 8T084

DIMENSION SKB(30), SCB(300), T84(6), T820(10), T827(6), T834(6), 1 T848(10), T849(10), T850(10), T857(6), BMSAVE(10)

COMMON/ORBINY/

1 T81, T82, T83, T84, T85, T86, T87, T88, T89, T810, T811, T812, T813, T814, T812, T813, T814, T815, T816, T817, T818, T819, T820, T821, 1822, 1823, 1824, 1825, 1826, 1827, 3 1828, 1829, 1830, 1831, 1832, T833, T834, T835, T836, 1837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, T836, T837, 
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WPOWCD
WPROP
WSORCE
WTPS
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CTIP
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SHORZ
TOEL
VBODY2
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, SOXTE
, TROOT
, VCARGO
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VOLCAL
VOLCAL
    64.
65.
66.
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, VBDDYA
                                                                                                                 4TTOT TTOTZ
5VCREW YFUTK
6VOXTK2 YPROP
CALL FRENCH
CALL VEHOF
CALL THRUST
RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             VOLCAL
VOLCAL
DATAIN
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    71.
72.
73.
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20 OCT 72 6.01-96



SUBRØUT I NE FLYBKP

| FORTRAN | MATH | CODE | DESCRIPTION | STORA | GE | SUBROUTIN | |
|---------------|--------|----------|---|------------|------|--|--|
| SYMBOL | SYMBOL | | DESCRIPTION | BLOCK | LOC | SUBR CODE | VAR |
| SCB | | M Worki | ng name for imput c-array booster scaling
clents | /0781NY/(| 144) | FLYBKP M
STORE M
SUMOUT I
TAMPER I
THRUST M
VEHOF I
WT VOL M | 5 C B
5 C B
5 C B
5 C B
5 C B
5 C B
5 C B |
| SE | | G Array | of synthesis iteration propulsion parameters | /S1ZING/(| 259) | FLYBEP D
PRITVA I
SIZEMR I
SUMOUT I.
TAMPER M
THRUST I
VEHDF M
WISCH I
WIVOL M | 55
55
55
55
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55
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55 |
| S e | | | hesis data array (37,5) that contains the
K data and some injection quantities | /SIZING/(| 74) | ENVPRA M FLYBKP M ISPRAT I POBC I PRITVA I REU3 O SIZEMR M SIZIN M SIZIN M SIZIN M SIZIN M TAMPAR D TAMPAR D THRUST M THRUST M TYPOF M | 55555555555555555555555555555555555555 |
| SA | | | hesis array (28) containing staging
ters and misc flags | /5121NG/(| | FLYBKP I
ITERS I
RANGE I
SIZEMR M
SIZIN I
SSSP I
SUMDUT I
TAMPAR O
TAMPER M
TATOSZ M
VEHDF M | 22222222222222222222222222222222222222 |
| T B 34 | | I Stored | booster value of or(i) | /0881 NY/(| 53) | ITERS O
SSSP M
STORE M
SUMDUT I
TAMPER I
VEHOF I | TB34
TB34
TB34
TB34
TB34
TB34
TB34
TB34 |

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SUBROUTINE FLYBEP
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7.
8.
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112.
13.
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FLYBKP
FLYBKP
SIZING
SIZING
SIZING
                 CC
                                                                SUBROUTINE TO CALCULATE FLYBACK PERFORMANCE PARAMETER
                                         C
                                                                                                                                                                                                             P2(5),
TLNG,
                                                                                                                                                                                                                                                                                                                                       SIZING
SIZING
SIZING
                                                                                                                                                                                                                                                                                                    SW(20),
                                                                                                                                                                                                                                                            ٧Q,
                                      PHASE I SIZING PARAMERERS

***BD, MLDD, DMEB, DMED, TOLMT, MPB, TWRATZ,
***BK1, BK2, GK3, BK4, ISIZE, TRAFLG, TWRATD,
***OK1, OK2, OK3, OK4, PRFLG, IPASS, IPSMAX,
***AEXIT, TVACD, NO, MFO, IDVEL, ISPO, ISPB,
***XPL, TVACB, NNB, MED, MEB, MO, MLD,
***OVD, DV9, MUB, MUD, MSTG, MPO
***JTVP BECD BSTG ORBIT ITNBM, ITNDM,
***SVOPSN SVOCCN IHUNT IOPSTG ISZOLT9
***OFMENSION SKB(30),568(300),764(6),782(10),7827(6),7834(6),
1 TB46(10),7849(10),7850(10),7857(6),8MSAVE(10)
COMMON/ORBINY,
1 TB1, TB2, TB3, TB4, TB5, TB6, TB7, TB8, TB9, TB1C, TB11, TB12, TB13, TB14,
2 TB15, TB16, TB17, TB18, TB19, TB20, TB21, TB22, 1823, 1824, 1825, 1824,
***TB41, TB42, TB43, TB44, TB45, TB43, TB47, TB46, TB49, TB50, TB51, TB52, TB53,
***STB63, TB60, TB61, TB62, TB63, TB64, TB47, TB46, TB49, TB50, TB51, TB52, TB53,
***CRUISE BROOSE AND TB61, TB77, TB78, TB79, TB80, TB81, TB82,
***TB11, TB72, TB73, TB74, TB75, TB76, TB77, TB78, TB79, TB80, TB81, TB82,
***TB11, TB72, TB73, TB74, TB75, TB76, TB77, TB76, TB79, TB80, TB81, TB82,
***TB11, TB72, TB73, TB74, TB75, TB76, TB77, TB76, TB79, TB80, TB81, TB82,
***TB11, TB72, TB73, TB74, TB75, TB76, TB77, TB76, TB79, TB80, TB81, TB82,
***TB11, TB72, TB73, TB74, TB75, TB76, TB77, TB76, TB79, TB80, TB81, TB82,
***TB11, TB72, TB73, TB74, TB75, TB76, TB77, TB76, TB77, TB76, TB79, TB80, TB81, TB82,
***TB11, TB72, TB73, TB74, TB75, TB76, TB77, TB76, TB77, TB76, TB77, TB80, TB81, TB82,
***TB11, TB72, TB73, TB74, TB75, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, TB77, TB76, 
                                                                                                                                                                                                                                                                                                    TWRATZ, SIZING
TWRATO, SIZING
IPSMAX, SIZING
ISPB, SIZING
SIZING
SIZING
SIZING
SIZING
18.
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ORBINY
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UH
28.
29.
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31.
33.
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38.
39.
412.
43.
                                                                                                                                                                                                                                                                                                                                        UH
                                                                                                                                                                                                                                                                                                                                        FLYBKP
FLYBKP
FLYBKP
FLYBKP
                                                                CRUISE PROPELLANT WEIGHT EQUATION
                                              FW(A,B,C,D) = WA = (1. - 1./EXP(1.689*A/C*B/D))
                                                                                                                                                                                                                                                                                                                                        FLYBKP
FLYBKP
FLYBKP
                                              IF( SV(21).WE.O.) GO TO 11
                                                                ADJUST FLYBACK RANGE
                                                                                                                                                                                                                                                                                                                                        FLYBEP
                                                                                                                                                                                                                                                                                                                                       FLYBKP
FLYBKP
FLYBKP
FLYBKP
FLYBKP
                                            SH(15) = PZ(5) + SQ(10,3)
                                 **** SW(15) IS THE FLYBACK RANGE ****
                                                             DETERMINE FLYBACK PROPELLANT WEIGHT REQUIRED
                                                                                                                                                                                                                                                                                                                                        FLYBKP
                                                                                                                                                                                                                                                                                                                                        FLYBEP
45.
46.
47.
48.
49.
50.
                                                                                                                                                                                                                                                                                                                                       FLYBKP
FLYBKP
                                  11 CONTINUE
                                              IFLY = 50(32,1)
60 TO (600,650,700),1FLY
                                                                                                                                                                                                                                                                                                                                       FLYBKP
FLYBKP
FLYBKP
                                                                                                                                                                                                                                                                                                                                                                         600--- 650-- 700-
                                                              USE BREGUET RANGE EQUATION FOR CRUISE RANGE PARAMETER
                            600 CONTINUE
DAUB = TB34(3) - SQ(19,2)

IF(SW(3).GT.1.5.AND.ABS(DAUB).GT..001)

ISE(5) = (SW(15) - SQ(19,1))/ DUMB

SQ(19,1) = SW(15)

SQ(19,2) = TB34(3)

SQ(19,3) = SW(14)/SW(12)*SW(11)/1.689

SCB(214)=EXP(SW(15)/SQ(19,3))

SCB(214) = SCB(214) + SV(20)/(SV(20) - SQ(32,4))

SCB(214) = SCB(214) - 1.

GO TO 800
                                                                                                                                                                                                                                                                                                                                      FLYBKP
FLYBKP
FLYBKP
FLYBKP
FLYBKP
51.
52.
53.
54.
55.
56.
57.
58.
                                                                                                                                                                                                                                                                                                                                        FLYBEP
                                                                                                                                                                                                                                                                                                                                        FLYBKP
FLYBKP
                                                                                                                                                                                                                                                                                                                                        FLYBKP
60.
61.
62.
63.
64.
                                                                                                                                                                                                                                                                                                                                       FLYBKP
FLYBKP
FLYBKP
                                                                                                                                                                                                                                                                                                                                                                                                                                          800
                                                                USE PERCENTAGE WEIGHT METHOD FOR DESCENT AND BREGUET RANGE EQUATION FOR CRUISE
                                                                                                                                                                                                                                                                                                                                        FIVREP
                            650 CONTINUE

DWF = $0(32,2) = $V(20)

$0(35,2) = DWF

WA = $V(20)

R2 = $W(15) - $Q(32,5) - $Q(33,1) - $Q(33,2)

DW = FW(R2,$0(33,4),$Q(34,2),$Q(34,5))

$Q(35,3) = DW

WA = WA - DW

DWF = DWF + DW
66.
67.
                                                                                                                                                                                                                                                                                                                                        FLYBKP
                                                                                                                                                                                                                                                                                                                                        CKOUT
                                                                                                                                                                                                                                                                                                                                        FLYBKP
FLYBKP
FLYBKP
FLYBKP
FLYBKP
FLYBKP
68.
69.
70.
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26 OCT 12 6.01-46

| 75.
76.
77.
78. C | DW = 50(32,3) + MA S0(35,4) = DW G0 T0 790 USE BREGUET EQUATION FOR DESCENT | FLYBKP
FLYBKP
FLYBKP
FLYBKP
FLYBKP | 796— |
|--|--|--|------|
| 80. C
81. 70
82.
83. | D CONTINUE
WA-SV(34)
DWF = FW(R1.50(33.3).50(34.1).50(34.4)) | FLYBKP
FLYBKP
FLYBKP
FLYBKP | |
| 84.
85.
86.
87.
88. | SQ(35,2) = DWF
WA = \$V(20) - DWF
R2 = \$W(15) - \$Q(32,5) - \$Q(33,1) - \$Q(33,2)
DW = FW(R2,5Q(33,4),\$Q(34,2),\$Q(34,5))
\$Q(35,3) = DW
DWF = DWF • DW | FLYBKP
FLYBKP
FLYBKP
FLYBKP | |
| 89.
90.
91.
92.
93. C
94. C | MR = MR - DW
DW = FM(R3,50(33,5),50(34,3),50(35,1))
SQ(35,4) = DM | FTABRA
LTABRA
LTABRA
LTABRA
LTABRA | |
| 95. C
96. 79
97.
98. | CALCULATE CRUISE RANGE PARAMETER CONTINUE DWF = DWF + DW + SQ(32,4) WA = WA - DW - SQ(32,4) | FLYBKP
FLYBKP
FLYBKP
FLYBKP
FLYBKP | |
| 103. | SCB(214) = DWF/MA
SQ(19,3) = SQ(34,5)/1.689*SQ(34,2)/SQ(33,4)
SQ(35,5) = R2
CONTINUE
RETURM | FLYBKP
FLYBKP
FLYBKP | |
| 104. | END . | FLYBKP | |
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SUBRØUT I NE FRENCH

| FORTRAN
Symbol | MATH
SYMBDL | CODE | DESCRIPTION | STORAG
BLOCK | LOC | | NE USAGE
DE VAR |
|-------------------|----------------|----------|---|-----------------|------|--|--|
| • | | | r of air breathing englnes used by set0 to set
n to zero | /CIMPUT/(| 1) | FRENCH I
FRENCH M
SETO O
STORE M
WTSCH I | ANENGS
A
ANENGS |
| ANENGS | | | of air breathing engines used by set0 to set
to zero | /CIMPUT/(| 1) | FRENCH I
FRENCH M
SETO O
STORE M
WTSCH I | ANENGS
A
ANENGS |
| FRENCH | | E Subro | tine to initialize vehicle sizing data | /FRENCH/(\$ | , | DATAIN S
FREACH E | FRENCH
FRENCH |
| 10 | | | mord array containing the basic deck, ince run, case and part case numbers in that | /CLOBAL/(| 211 | BLICO I
FRENCH I
GEINP I
PADSI D
PRINT I
SOINP I
TOPM I
VEHDF I | 1D
1D
1D
1D
1D
1D
1D |
| ITPS | | 0 Thermo | protection fing | /CINPUT/(| 336) | FRENCH O
STORE M
MTSCH M | 1 TPS
1 TPS
1 TPS |
| J URP | | 0 Data f | ing 0= orbiter 1= booster | /JUMPY /(
 | 13 | FRENCH O
PRINTW I
PRITVA I
PRWTSM M
WTSCH I
WTVOL M | JUMP
JUMP
JUMP
JUMP
JUMP
JUMP |
| NUL | | 0 Wing 1 | ceding fleg | /CINPUT/(| 379) | FRENCH O
STORE M
WTSCH M | NUL
NUL |
| STORE | | | tine to store vehicle data in internal format
vol format | /STORE /(\$ | , | FRENCH S
STORE E | STORE
Store |
| TRAFLG | | | c control flag O. Sizing loop net converged
zing loop converged 2. Error in sizing loop
ase | /SIZING/(| 284) | FRENCH O
1TER8 O
PADS1 I
SIZE M
SSSP O
VEHOF O | TRAFLG
TRAFLG
TRAFLG
TRAFLG
TRAFLG
TRAFLG |

| FORTRAN
SYMBOL | MATH
Symbol | CODE | DESCRIPTION | STORAGE
BLOCK LOC | SUBROUTIN
SUBR COD | E USAGE
E VAR |
|-------------------|----------------|-----------|-----------------|----------------------|-----------------------|------------------|
| .UN06. | | O File of | all output data | /.UN06./(s | BLICO 0 | . UN06. |
| | | | · | | BADRYC O | . UNG6. |
| | | | | | CRASH O
French O | . UNO6. |
| | | | | | FXDAT 0 | . UNO6. |
| | | | | | GEINP O | . UNO 6 . |
| | | | | | HUNT 0 | . UNO 6 . |
| | | | | | INEDIT O
ITER8 O | . UNO6. |
| | | | | | MODELA O | . UNO6. |
| | | | | | MOMJ 0 | . UNG6. |
| | | | | | MPSI O | . UNO6. |
| | | | | | 0 UT 0 | . UNC6. |
| | | | | | PAYO2 O
Print o | . UNO6. |
| | | | | | PRINTY 0 | . UNO6 |
| | | | | | PRINTW 0 | . UNO6. |
| | | | | | PRITEG O | . UNO6 |
| | | | | | PRITVA O
Propin o | . UNO6. |
| | | | | | PROTHE O | . UNO6. |
| | | | | | PRWTSM 0 | . UNO 6. |
| | | | | | RANGE D | . UNO6. |
| | | | | | S O
SDINP O | . UNO6. |
| | | | | | 512E 0 | . UNO6. |
| | | | | | SIZIN D | . UND6. |
| | | | | | SIZOUT O | . UNG 6 . |
| | | | | | SOLVE O | . UNO6. |
| | | | | | SPLICO O
SPLIZ O | . UNO6. |
| | | | • | | SPLYNE D | . UN06. |
| | | | | | SSSP 0 | . UN06. |
| | | | | | STAU 0 | .UND6. |
| | | | | | STPIT 0
SUMOUT 0 | .UNG6. |
| | | | | | TABIN 0 | . UNG6. |
| | | | | | TEST O | . UNO6. |
| | | | | | VEHDF 0 | . UNO6. |
| | | | | | MTSCH 0 | . UNO6. |
| | | | | | MIAOT D | . UNO6. |

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$ 5. $ C
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FRENCH
FRENCH
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                                                                                                                                                                      SUBROUTINE FRENCH
                1.
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                                                                                                                                                                                                                                  SUBROUTINE TO INITIALIZE BOOSTER AND ORBITER COMMON BLOCKS OF DATA
                                                                                                                                                     COMMON/PO/ MPRNT, MPNCH
COMMON/JUMPY/ JUMP, MBIG, MBOO
COMMON/GLOBAL/
*GR , OMGZ , XLAMRF
*, JJOP(10) | IFATAL , NARC , NBRAN
*, KTAB(20) | TAB(20) , SIG , MAXTAB
*, GM , PSIRF, IPFLG1 , IPFLG2, IPFLG
*, ITPSO , KSOL , KGLOBL(8)
REAL KIM
REAL ISP K, LF, MR, NCREW, LBODY, NPASS
REAL NEMSS , COMMON/CIMPUT/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     FRENCH
FRENCH
GLOBAL
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       BLOBAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GLOBAL
GLOBAL
GLOBAL
GETAP
CIMPUT
CIMPUT
CIMPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IPFLG2, IPFLG3, IPFLG4, INEQFL( 20)
REAL ISP K, LF, AR, NCREW, LBODY, NPASS
REAL MEMBS
COMMON/CIMPUT/
IANENSS ANTANK
CSBODY, CSBODY, CSBODY, CSFAIR CSFUTK CSMORZ CSOXTK CASSPLAN CSVERT CSWING CTHAST CTHSTZ OFF(5) FXWOVS
AISP(A) (ITPS K(30) KIM LF
SNENGS NLISTO NPASS NWL PCHAM DRAFF AR(6), NCREW CHORD COMMON/CREW CHOSS
OIMENSION SKO(30), SCO(300), TO4(6), TO2C(10), TO2T(6), TO34(6),
1 TO48(10), TO49(10), TO5C(10), TO5T(6), DWSAVE(10)
COMMON/CRBINK/
1 TO1 TO2 TO3 TO4 TO5 TO6 TO7 TO8 TO9 TO10 TO11 TO12 TO13 TO14
2 TO15 TO16 TO17 TO8 TO9 TO10 TO11 TO12 TO13 TO14
2 TO15 TO16 TO17 TO8 TO9 TO10 TO11 TO12 TO13 TO14
3 TO24 TO17 TO4 TO5 TO6 TO7 TO8 TO9 TO10 TO11 TO12 TO13 TO14
4 TO41, TO42 TO3 TO4 TO5 TO6 TO7 TO8 TO9 TO10 TO11 TO12 TO13 TO14
5 TO54 TO55 TO56 TO57 TO66 SKO, SCO OWSAVE
6 TO59 TO66 TO57 TO66 SKO, SCO OWSAVE
6 TO59 TO66 TO56 TO57 TO66 TO77 TO78 TO79 TO68 TO69 TO70 TO71,
7 TO72 TO73 TO74 TO75 TO76 TO77 TO78 TO79 TO68 TO69 TO70 TO71,
7 TO72 TO73 TO74 TO75 TO76 TO77 TO78 TO79 TO68 TO69 TO70 TO71,
7 TO72 TO73 TO74 TO75 TO76 TO77 TO78 TO79 TO60 TO81 TO82 TO83,
61084
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CIMPUT
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CKOUT
UM
                                                                                                                                                T 1072,1073,1074,1075,1076,1077,1078,1079,1080,1081,1082,1083,
81084
DIMENSION SK8(30), SCB(300), TB4(6), TB20(10), TB27(6), TB34(6),
1 TB48(10), TB49(10), TB50(10), TB57(6), BMSAVE(10)
COMMON/ORBINY/
1 TB1, T62, T83, T84, T85, T86, T87, T88, T89, T810, T811, T812, T813, T814,
2 T815, T816, T617, T818, T819, T820, T621, T822, T823, T824, T825, T826, T827,
3 1828, 1829, 1830, 1831, 1832, T833, T834, T835, T836, T837, T838, T839, T840,
4 T841, T842, T843, T844, T845, T846, T847, T848, T849, T850, T851, T852, T853,
5 T854, T855, T856, T857, SK8, SC8, BMSAVE
6 T859, T850, T861, T862, T863, T864, T867, T868, T867, T868, T869, T870, T871, T872, T873, T874, T875, T876, T877, T878, T879, T880, T881, T882,
8 T883, T884
COMMON/WICCALC/ ABFSYS WABFTK WABFU WABFU WACRES
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MBASIC MBODY
MDECAY MDISTI
MELCAD MENOTY
MFOCAY MFOST
MFUDX MFURES
MGASPR MGNAY
MINST MINSUL
MNACEL MODCAY
MOXZO3) MOXID
MOXTOT MAXTAP
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WPOWFO
WREFUL
WSTAB
WWAIT(10)
WANFTP
WGAS
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, WTPS
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, WPWFRS
, CTIP
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BWABFUC WALDRS WACFRS
COMMON/VOLCAL/BBOOY CROOT
2HBOOY LBODY RIOD
3SPLAN STPS(1) SVERT
4TTOT TOTAL
5VCREW VFUTK VFUTK2
6VOXTK2 VFROP VSTRUC
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WPWORS
CSPAN
SFAIR
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,SHORZ
,TOEL
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VBODYA
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VOTHER
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                                                                                                                                                                6 YOXTK2 YPROP , VSTRUC
OIMENSION A(392)
EQUIVALENCE (A, ANENGS)
REAL MUB, MUD, ISPB, ISPO, IDVEL, NNB, NO
COMMON /SIZING/
                                                                                                                                                                                                                                            PHASE II SIZING PARAMERERS
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20 DCT 72 6.01-46

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SW(20), SIZING
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TWRATO, SIZING
ISPB, SIZING
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BK4,
OK4,
WFO,
WEO,
MUD,
ORBI,
JOPSTG
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151ZE,
PRFLG,
10VEL,
WEB,
VSTG,
17NBW
                                                                                                                                                                                                                                                                                                                                                                                                     WPB,
TRAFLG,
IPASS,
ISPO,
WO,
                                                                                                                                                                                                                                                                                                                                                                                   LINON
                                                                                                                                                                                                                                                                                                                      , i $ 20(14)
                                                                                                                                                                                                                                                   ASHEEP
CSFAIR
CTHRST
KIN
NWL
SBODY
                                                                                                                                                                                                                                                                                                                                                                   CBBODY CFUEL
CSHORZ CSOXTK
FXWOVS
AR FXWEW
O RHOFU
TOVERC TPRATO
                                                                                                                                                                                                                                                                                                          CSFUTK
CTHST2
LF
PCHAM
TOL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         UH
UH
UH
UH
UH
FRENCH
FRENCH
FRENCH
                                                                                                       READ ORBITER DATA AND STORE IN INTERNAL FORMAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         FRENCH
CKOUT
FRENCH
CKOUT
UH
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UH
CKOUT
                                                                             IPC = 31
JUMP = 0
CALL SETO
CALL TABIN(DUM, 1, A, 392, RUMMY, 1, ID, IPC, 0, IEOD)
IF(IEOD.NE.O) 60 TO 1
102.

103.

104.

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107.

108.

1109.

111.

C C

1113.

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                                                                            MPRNT = A(205)
ITPS=A(336)
NWL= A(379)
IF(APRNT.E0.1) WRITE(6,PRNTX)
IF(ANENGS.E0. O. ) ANENGS = 1.
CALL STORE
CALL ORBSTO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         UM
CKOUT
FRENCH
FRENCH
FRENCH
FRENCH
                                                                                                     READ BOOSTER DATA AND STORE IN INTERNAL FORMAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         FRENCH
CKOUT
FRENCH
                                                                            IPC = 32
JUMP = 1
CALL SETO
CALL TABIN(OUM,1,A,392,RUMMY,1,ID,IPC,0,IEOD)
IF(IEOD.NE.O) 60 TO 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          UH
UH
CKOUT
                                                                           MPRNT = A(205)

MML= A(379)

ITPS=A(336)

IF(APRNT.EQ.1) MRITE(6,PRNTX)

IF( ANENGS.EQ. 0. ) ANENGS = 1.

CALL STORE

CALL BOOSTO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          UH
UH
UH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         UH
CKOUT
FRENCH
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                                                                                                    RETURN TO SYNTH PROGRAM
                                                                             RETURM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FRENCH
 131.
132.
133.
134.
135.
                                                                1 MAITE(6,2)
2 FORMAT(22H NO SIZING DATA INPUT
TRAFLE=2.
CALL SIZERR
END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           UH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           UH
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FRENCH
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SUBRØUT I NE HUNT



| OBTHAN | MAIH | CODE | DESCRIPTION | STORAG | | SUBAR | JT] NE | USAGE |
|-----------|--------|------|---|-------------|-----|--|-------------|---|
| 244801 | SYMBOL | 1001 | DESCRIPTION | BLUCK | LOC | SUBR | C008 | RAV |
| | | | | | | | | |
| BLOW | | I | Idle descent range increment for flyback calculations | /DATA2X/(| 70) | HUNT | I | 810M |
| EROR | | 1 | Number of booster engines | /SIZING/(| 19) | HUNT
SSSP
WTVOL | I
I
0 | EROR
EROR
EROR |
| PNDX | | 1 | Solid motor thrust slope | /DATA2X/(| 60) | HUNT | I | PNDX |
| RVAR | | 1 | Solid motor thrust curve intercept | /DATA2X/(| 59) | HUNT | 1 | RVAR |
| SGRT | | F | Square root function | /SQRT /(\$ |) | ANLATE
CRASH
DCTOE
DERSA
ENVPRE
HUNT
MODELA
OPWELL
OUT
PAT63
PAY02
PDY3A
STORE
SYMVRT
WTSCH | 7 A A B | SORT
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| . UNO 6 . | | 0 | File of all output data . | /.UN06./(\$ | , | BLICO
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OR BINY
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DATAZX
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                   INDPA =ABS(PAYX)

SI=1.

IF(PAYX.GT.O.) SI=-1.

PAY = A(INDPA)*SI

CALL POWEL(PYAR,NVAR,STAP,EROR,PAY)

TEST FOR CONVERGANCE

OD 20 I=1 NVAR

INDX = PNDX(I)

A(INDX) = BOX(PYAR(I),I)

SIEP(I)=BOX(STAP(I),I)

20 CONTINUE

IF(CON.NE.-1) RETURN

PAYO=A(INDPA)

WRITE(6,103) PAYO

103 FORMAT(35HO POWELL HAS CONVERGED TO A PAYOFF=E2O.8)

RETURN
                                                                                                                                                                                                                                HUNT
                                                                                                                                                                                                                                HUNT
                                                                                                                                                                                                                               HUNT
                                                                                                                                                                                                                                HUNT
62.
63.
64.
           C
                                                                                                                                                                                                                               HUNT
HUNT
                                                                                                                                                                                                                               HUNT
                                                                                                                                                                                                                               HUNT
65.
66.
67.
68.
69.
70.
71.
                                                                                                                                                                                                                               HUNT
                                                                                                                                                                                                                                HUNT
                                                                                                                                                                                                                                HUNT
HUNT
                                                                                                                                                                                                                               HUNT
                               RETURN
                                                                                                                                                                                                                                HIINT
```

20 OCT 72 G.01-46

SUBRØUT I NE I TER8

| FORTRAN | MATH | CODE | DESCRIPTION | STORAG | | SUBROU | TIN | E USAGE |
|---------|--------|------|--|-------------|------|--|--------------------------------------|--|
| SYMBOC | SYMBOL | | DESCRIPTION | BLOCK | LOC | SUBR | COO | E VAR |
| ITER8 | | E | Subroutine to evaluate synthesis convergance and call for flyback range calculations and summary page output | /ITER8 /(\$ | , | ITERB | £ | ITERB |
| RANGE | | S | Subroutine to evaluate booster flyback range based on flybck | /RANGE /(\$ |) | ITER8
RANGE | S
E | RANGE
RANGE |
| SV | | 1 | A synthesis array (28) containing staging parameters and misc flags | /S1ZING/(| 46) | ENVPRM
FLYBKP
ITER8
RANGE
SIZEM
SIZEM
SIZEM
SIZEM
SIZEM
SIZEM
SIZEM
TAMPER
TAMPER
TRIOSE
WIVOL | 1
1
1
1
1
1
1
0 | 25 |
| T839 | | 0 | Stored booster value of wr(i) | /DRBINY/(| 53) | TTER8
SSSP
STORE
SUMOUT | I | TB34
TB34
TB34
TB34
TB34
TB34
TB34 |
| TOLER | | w | Orbiter cass ratio toleranceschieved | /ITER8 /(+ |) | I TER8 | H | TOLER |
| T034 | | • | Stored orbiter value of er(1) | /ORBI NX/(| 53) | ITER8 SSSP STORE TAMPER VEHDF WTVOL | N
I
O | T034
T034
T034
T034
T034
T034 |
| TRAFLS | | | Traffic control flag O. Sizing loop not converged
1. Sizing loop converged 2. Error in sizing loop
next case | /SIZ1NG/(| 284) | FRENCH
1TERB
PADS1
S1ZE
SSSP
VEHDF | 0
M
0 | TRAFLG
TRAFLG
TRAFLG
TRAFLG
TRAFLG
TRAFLG |

| 600 | |
|-----|--|
| 1 | |

SUBBOUTINE USAGE Subb code var MATH SYMBOL FURTHAN STORAGE BLOCK L DESCRIPTION CODE LOC SYMBOL BLICO D BNDRYC D CRASH O FRENCH D FXDAT D GEINP D .UNO6. .UNO6. . UNO6. File of all output data 1.UN06./(s .UN06. .UN06. HUNT DINEOUT O INEOUT O OTTERS O OTTERS O OTTERS O OTTERS O OPRITED O PRITED O PROTING O PROTING O OPROTISM O ORANGE O OS HUNT . UN06. . UN06. .UN06. .UN06. . UNO6. .UN06. .UN06. .UN06. .UN06. .UN06. . UN06. .UNO6. .UNO6. .UNO6. PRWTSM D
RANGE 0
SS OINP 0
SIZE 0
SIZIN 0
SIZIN 0
SIZUUT 0
SPLICO 0
SPLIZ 0
SPLIZ 0
SPLIZ 0
SPLIZ 0
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STAU 0
STAU 0
STAU 0
STAU 0
STAU 0
STAU 0
STAU 0
STAU 0
STAU 0 .UN06. .UN06. .UN06. . UN06. .UN06. .UN06. .UN06. .UN06. .UNO6. .UNO6. .UNO6.



```
CKOUT
ITER8
ITER8
ITER8
SIZING
SIZING
                                                                     PROGRAM ITERS
   12345678901234567890123456789012345
                                C
C
C
                                                           REAL MUB, MUO, ISPB, ISPO, IDVEL, NNB, NO
COMMON /51ZING/
PHASE II SIZING PARAMERERS
*II, VV(3)
*SV(28), SC(31,5), SE(11), TLAT, TLNG,
PHASE I SIZING PARAMERERS
*MBO, WLOO, DWEB, OWEO, TOLWT, WPB, TWRATZ,
*OKI, OKZ, OK3, OK4, PRFLG, IPASS, IPSMAX,
*AEXIT, TVACO, NO, WFO, IDVEL, ISPO, ISPB,
*WPO, DVO, DWB, MUO, WEB, MO, WFO, IDVEL, ISPO, ISPB,
*WPU, TVACB, NNB, WEO, WEB, MO, WLO,
*SYPL, TVACB, NNB, MEO, WEB, MO, WLO,
*SYPL, TVACB, NNB, MUO, VSTG, MFO,
*JTVP, BECO, 8STG, DRBI, ITNBM, ITNOM,
*SVDPSQ, SVDCON, IHUNT, IDPSTG, ISZD(16)
DIMENSION SKO(30),5CO(300),TO4(6),T025(10),T027(6),T034(6),
*TO48(10),T049(10),T050(10),T057(6),DWSAVE(10)
COMMON/ORBINX/
*TO15,T016,T017,T018,T014,T025,T021,D022,D023,D024,D025,D026,T027,
*T019,T02,T03,T04,T05,T06,T07,T08,T09,T010,T011,T012,T013,T014,
*T011,T042,T03,T044,T045,T046,T047,T048,T049,T050,T051,T052,T053,
*T054, T055,T056,T057,T056,SKO,SCO,OWSAVE
6,T059,T060,T061,T062,T063,T077,T078,T079,T068,T069,T070,T071,
*T072,T073,T074,T075,T076,T077,T078,T079,T068,T069,T070,T071,
*T018WSION SKB(30),SCB(300),T84(6),TB20(10),TB27(6),TB34(6),
                                                                                             SUBROUTINE TO CHECK SYNTHESIS LOOP FOR CONVERGENCE
                                                                                                                                                                                                                                                                                                                                                                                                                                         SU(20), SIZING
SU(20), SIZING
SIZING
SIZING
                                 C
                                C
                                                                                                                                                                                                                                                                                                                                                                                                                                        SIZING
THRAT2, SIZING
THRAT0, SIZING
IPSMAX, SIZING
ISPB, SIZING
SIZING
SIZING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        UH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CKOUT
ORBINX
ORBINX
ORBINX
ORBINX
CKOUT
UH
UH
ORBINY
ORBINY
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ORBINY
                                                            7 T072, T073, T074, T075, T076, T077, T078, T079, T080, T081, T082, T083, 8T084
DIMENSION SKB(30), SCB(300), TB4(6), TB20(10), TB27(6), TB34(6),
1 T848(10) T849(10), T850(10), T857(6), BMSAVE(10)
COMMON/ORBINY/
1 TB1, T82, T83, T84, T85, T86, T87, T88, T89, T810, T811, T812, T813, T814,
2 TB15, T816, T817, T818, T819, T820, T821, T822, T823, T824, T825, T826, T827, T831, T814, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819, T819
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ORBINY
UH
UH
  39.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        UN
UH
ITER8
ITER8
ITER8
ITER8
ITER8
ITER8
                               0000000
                                                                   SW(2) = 2 FOR CONVERGED RUN
SW(2)=1. FOR LAST PASS
SW(2) = .5 FOR ITERATION
                                                                                           CALCULATE IMPULSE MASS RATIOS
  46.
47.
48.
49.
50.
51.
52.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ITERB
ITERB
ITERB
ITERB
                                                                   CALL SIZEMR
                               CCC
                                                                                           CALC ERROR IN MASS RATIO AND PRINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ITERS
ITERS
ITERS
                                                                    TOLER = ABS( T034(3) - SV(6) ) / SV(6) WRITE (6,1005) SV(6),T034(3), SW(3),SW(5),T0LER
   54.
55.
56.
57.
59.
                               CCC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ITERB
ITERB
ITERB
                                                                                           CHECK FOR SUCCESSFUL CONVERGENCE
                                                                    IF(TOLER.LT.SM(5)) 60 TO 1 60 TO 11
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CKOUT
ITERB
                                C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ITERB
60.
61.
62.
63.
64.
65.
                                                       1 SW(2) = 2.
TRAFLG = 1.0
GO TO 11
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CKOUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CKOUT
CKOUT
ITER8
                           0000
                                                                                           SET ORBITER MASS RATIO FOR WIVOL ROUTINES
                                                                                           CALL FLYBACK RANGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ITERS
                                                11 T034(3) = SV(6)
TB34(3) = SV(28)
CALL RANGE
CALL FLYBKP
IF( SW(2).GE. 1.) RETURN
 67.
68.
69.
70.
71.
72.
73.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ITERS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        UM
ITER8
ITER8
ITER8
ITER8
ITER8
                              000
                                                                                            IF MASS RATIO ERROR TOO LARGE PRINT
```

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0



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SUBRØUT I NE ØPWELL



| SYMBOL | MATH
Symbol | CODE | DESCRIPTION | STORAGE
BLOCK L | SUBROUTINE USASI
OC SUBR CODE VAR |
|--------|----------------|----------|---------------|--------------------|---|
| SORT | | F Square | root function | /SQAT /(\$ | ANLATM F SORT CRASM F SORT DCTOE F SORT DER3A F SORT ENVPRM F SORT HUNT F SORT MODELA F SORT OPWELL F SORT OPWELL F SORT PATO3 F SORT PATO3 F SORT POBC F SORT POBC F SORT SYMVRT F SORT WISCH F SORT |

 \mathcal{K}°

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OPWELL
OPWELL
OPWELL
JULY28
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JULY28
     ,PVS(10) ,
                                      BEGIN LOGIC FOR SUBROUTINE POWELL
  IF(EM.GE.1) 60 TO 19
                                          FIRST PASS LOGIC
                                                                                                                                                                                 10F458
10F458
10F458
d
                                                                                                                                                                                 10FA58
10FA58
10FA58
                                                                                                                                                                                 JULY28
JULY28
JULY28
JULY28
JULY28
JULY28
JULY28
                                                                                                                                                                                                 17.
                                                                                                                                                                                 JULY28
     44.
45. C
46. C
47. C
48. C
49. C
50. C
                                                                                                                                                                                101458
101458
101458
101458
                                          CHECK VALUE OF MOUNT.

1.) IF MOUNT EQUAL ZERO STORE INFORMATION REQUIRED FOR ACCELERATED LINEAR SEARCH.

2.) IF MOUNT EQUAL ONE CONTINUE WITH QUADRATIC SEARCH.
                                                                                                                                                                                 JULY28
JULY28
JULY28
                      19 IF(MOUNT.EQ.1) 60 TO 100
                                                                                                                                                                                 JULY28 100-
      52.
                       20 COUNT = COUNT +1

XT(1) = XT(2)

XT(2) = XT(3)

XT(3) = DEL(11)

AT(1) = AT(2)

AT(2) = AT(3)

AT(3) = PAY
                                                                                                                                                                                 JULY28
JULY28
JULY28
     53.
54.
55.
56.
57.
58.
60.
61.
62.
63.
                                                                                                                                                                                 JULY28
JULY28
JULY28
JULY28
JULY28
JULY28
JULY28
JULY28
                              IF(COUNT.GE.2) GO TO 70
                                                                                                                                                                                                 70-
                                          SAVE PAYOFF TO CHECK IF ACCELERATED LINEAR SEARCH SHOULD BE ENDED.
                                                                                                                                                                                 JULY28
JULY28
                                                                                                                                                                                JULY28
JULY28
JULY28
JULY28
JULY28
JULY28
JULY28
     65.
66.
67.
68.
69.
70.
71.
                       52 PASAV = PAV
                                           COMPUTE STEP SIZE FOR USE IN ACCELERATED LINEAR SEARCH, AND COMPUTE NEW VALUE OF PV.
                      VAL = 0.

00 53 I=1,N

53 VAL = VAL + (66(II,I)/STEP(I))+2

OEL(II) =1./SQRT(VAL)
d
```

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```
1
                                     DEL(11) = 2.**COUNT*DEL(11)/(2.*EN)
DEL(11) = SC * DEL(11)
DD 55 1 = 1, N
55 PV(1)= PPN(1) + DEL(11)*GG(11,1)
                                                                                                                                                                                                                                                                                       JULY28
JULY28
JULY28
JULY28
JULY28
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JULY28
JULY28
JULY28
JULY28
         74.
756.
7778.
8123.
888.
888.
889.
9923.
                                                                   COMPARE VALUES FROM ACCELERATED LINEAR SEARCH.

1.) IF FIRST THREE POINTS FORM A CONCAVE UPWARD SET, GO TO QUADRATIC SEARCH.

2.) IF PAY IS LESS THAN PASAY, SET PASAY EQUAL TO PAY, COMPUTE NEW STEP SIZE AND NEW YALUE OF PY.

3.) IF PAY IS GREATER THAN OR EQUAL TO PASAY A.) IF COUNT IS EQUAL TO PASAY EDIAL TO PAY, REVERSE THE DIRECTION OF NEW STEP, COMPUTE NEW PY.
                                                                                                                                                           NEW PV.
IF COUNT NOT EQUAL TO TWO BEGIN
QUADRATIC SEARCH.
         94.
95.
96.
97.
98.
                                     70 | F(PAY.GT.AT(1).AND.SC.EQ.-.5.AND.COUNT.EQ.3) SO TO 75 | F(PAY.LT.PASAY) GO TO 52 | F(CDUNT.EQ.2) GO TO 90
                                                                                                                                                                                                                                                                                       JULY28
JULY28
JULY28
JULY28
                                                                                                                                                                                                                                                                                                                   52 —
90 —
                                                                    BEGIN QUADRATIC SEARCH.
                                                                                                                                                                                                                                                                                       JULY28
                                   75 MC=NC+1
AA = (XT(2)-XT(3))+AT(1)
BB = (XT(3) - XY(1))+AT(2)
CC = (XT(1) - XT(2))+AT(3)
A5 = (XT(2)+2-XT(3)+2-2)+AT(1)
B5 = (XT(3)+2-XT(1)+2-2)+AT(2)
CS = (XT(1)+2-XT(2)+2-2)+AT(2)
DD = (AS+BS+CS)/(AA+BB+CC)
DD = (S+DD
D(MC) = DD
PASAV = PAY
DO 85 i=1, M
85 PV(1) = PPN(1) +DD*GG(II, I)
#BOUNT = 1
RETURN
      100.
                                                                                                                                                                                                                                                                                       JULY28
                                                                                                                                                                                                                                                                                       JULY28
JULY28
JULY28
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JULY28
JULY28
      101.
102.
103.
104.
      105.
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     107.
108.
109.
110.
111.
112.
113.
114.
115.
116.
D
                                                                                                                                                                                                                                                                                       10FAS8
10FAS8
10FAS8
10FAS8
                                                                   REVERSE DIRETION OF STEP.
                                                                                                                                                                                                                                                                                       JULY28
     118.
119.
120.
121.
122.
123.
124.
125.
126.
                                                                                                                                                                                                                                                                                       107.458
107.458
107.458
107.458
107.458
107.458
                                     90 SC = -.5
60 TO 52
                                                                                                                                                                                                                                                                                                                   52-
                          00000000
                                                                   CHECK VALUE OF LOU.

1.) IF LOU EQUAL TO ONE, CHECK CONVERGENCE OF QUADRATIC SEARCH

2.) IF LOU EQUAL TO ZERO, THROW AWAY WORST VALUE OF ACCELERATED LINEAR SEARCH AND REPLACE BY RESULT OF QUADRATIC SEARCH
                                                                                                                                                                                                                                                                                       JULY28
                                  100 V(NC)= PAY
     128
                                                                                                                                                                                                                                                                                       JULY28 15G-
                                              IF(LOU.EQ.1) 60 TO 150
      129.
                                 105 PMAX = AMAX1(AT(1), AT(2), AT(3) )

00 120 [=1,3

IF(PMAX.EQ. AT(1)) 60 TO 121

120 CONTINUE
     130.
                                                                                                                                                                                                                                                                                       JULY28
JULY28
      132.
                                                                                                                                                                                                                                                                                       JULY28
JULY28
    134.
135.
136.
137.
138.
                                121 JM = 1

PMIN = AMIN1(AT(1), AT(2), AT(3))

DO 130 J = 1, 3

IF(PRIN.EQ.AT(1)) GO TO 131
                                                                                                                                                                                                                                                                                       101 728
                                                                                                                                                                                                                                                                                       JULY28
JULY28
JULY28
                                                                                                                                                                                                                                                                                                                131-
                                 130 CONTINUE
                                130 COM; | MODE

131 JS = I

JL = MOD(JM+JS, 4)

IF(JL.EQ.O) JL = 2

FM1 = AMAXI(ZT(1), XT(2), XT(3))

FM2 = AMINI(XT(1), XT(2), XT(3))

IF(DD.GT.FM1.OR.DD.LT.FM2) GO TO 141

IF(XT(JM).EQ.FM1.AND.XT(JL).EQ.FM2) GO TO 137
     139.
140.
141.
142.
143.
144.
145.
                                                                                                                                                                                                                                                                                      JULY28
JULY28
JULY28
JULY28
JULY28
JULY28
JULY28 141-
JULY28 137-
```

| 146. | IF(XT(JM).EQ.FM2.AND.XT(JL).EQ.FM1) GD TO 135 | JULY28 13 | |
|-------------------|--|-------------------------|-------------------|
| 147. | 60 TO 141
5 IF(OD.6T.XT(JS)) 60 TO 141 | JULY28 | |
| 149. | GO TO 145 | JULY28 14 | 5-1 |
| | 7 IF(DD.GT.XT(JS)) GD TO 145
1 XT(JM) =DD | JULY28 T4 | <u>'</u> |
| 152. | AT(JM) =PAY
60 TO 149 | JULY28
JULY28 14 | ,_ |
| 154. 14 | 5 XT(JL) =DD | JULY28 | + |
| | AT(JL)= PAY 9 LOU =1 | JULY28 | |
| 157. | 60 TO 75
0 IF(NC.GE.7) 60 TO 152 | JULY28 15 | |
| 159. | 1F(PAY.GT.PASAV) 60 TO 105
TT=.2 | JULY28
JULY28 | 105- |
| 161. | IF(N.EQ.1) TT=.05 | JULY28
JULY28 | 105- |
| 162.
163. | IF(PASAV-PAY.GT.TT*PASAV) GO TO 105
IF(NT.EQ.2) GO TO 152 | JULY28 15 | |
| 164. | NT = NT+1
IF(PAY.GT.PAO) GO TO 105 | JULY28 | 105- |
| 166. C | IF N EQUAL TO ONE, SET CON EQUAL TO ONE AND RETURN | JULAS8 | - 1 |
| 168. C | | JULY28 | |
| 169. 15
170. | 2 IM=1
VMIN=V(1) | JULY28 | |
| i71: | DO 153 1=2,NC
1F(VMIN.GT.V(I)) IM=I | JULY28
JULY28 | |
| 4173. 15 | 3 VMIN = V(IM) | JULY28 | |
| 1174.
1175. | DD = D(IM)
DD 154 I=1,N | 10FA58 | |
| 175.
176. 15 | 4 PV(1) = PPN(1)+DD+ 6G(11,1)
PAY=V(1M) | JULY28 | |
| 178. | NT=0 | 10FAS8 | |
| 179. | NC=0
IF(N.EQ.1) GOTO 252 | JULY28
JULY28 25 | 2- |
| 181.
182. C | IF(13.EQ.N+1) 60 TO 200 | JULY28 20 | ٩٦l |
| 183. C | RESET FOR NEW MINOR OR COMBINED SEARCH. | JULY28 | - [] |
| H185. | DO 155 [=1,N | 10FA58 | <u>li</u> |
| 4186. 15
1187. | 5 PPN(I) = PPN(I) + DD+GG(II,1)
NT = 0 | JUL458 | ll l |
| 188.
189. | SC=1.
COUNT =0 | JULY28
JULY28 | Ш |
| 190. | MOUNT = 0 | JUL458 | - [] |
| 191.
192. | LOU = Q
NP1=N+1 | JULAS8 | - 11 |
| 口193.
口194. 16 | DO 160 I=1,NP1
O DEL(I) = 0. | JUL458 | Ħ |
| 195. | II=11+1 | JULY28 | t ₂ ^. |
| 196.
197. C | IF(II.LE.N) GO TO 20 | 107458 | 20. |
| 198. C
199. C | COMPUTE COMBINED DIRETION. | JUL458 | |
| 200. | GVAL=0
DD 175 1 = 1,N | JULY28
JULY28 | - [] |
| C201: 17 | 5 GVAL = GVAL+(PPN(1)-PVS(1)) + + 2 | JULY28 | - [] |
| 203.
204. | GVAL = SQRT(GVAL)
DD 180 1 = 1,M | JULY28 |]] |
| 1205. 18 | 0 GG(11,1) = (PPN(1)-PVS(1))/GVAL
60 TO 20 | JULY28 | 20- |
| 207. C | | JULY28 | 11.3 |
| 208. C
209. C | CHECK CONVERGENCE OF PROBLEM. | JULY28 | |
| C210. 20 | 0 DD 250 I =1.M
0 IF(ABS(PVS(1)-PV(I)).GT.EPP(I)) GD TO 255 | JULY28
JULY28 25 | 5— |
| 212. 25
213. | 2 CON = 1
Return | JULY28
JULY28 | 7 |
| 214. C | | JULY28 | |
| | INCREMENT EN. 1.) IF EN IS LESS THAN OR EQUAL TO ELIM RESET | | |

```
FOR NEW MAJOR
2.) IF NOT, SET CON EQUAL TO ZERO AND RETURN.
          217. C
218. C
219. C
                                                                                                                                                                                                                                                                                                                                                                               JULY28
JULY28
JULY28
          220.
221.
222.
223.
                                                                                                                                                                                                                                                                                                                                                                              JULY28
JULY28
JULY28
JULY28
                                               255 EN=EN+1

IF(EN.LE.ELIM ) GO TO 260

CON = O

RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                 260-
                                            RETURM

260 00 261 I = 1 N
PVS(I) = PV(I)

261 PPM(I) = PV(I)
NT = 0
PAO = PAY
II = 1
SC = 1.
COUNT=0
MOUNT = 0
LOU = 0
NP1=N+1
DO 265 I=1,NP1
265 DEL(I) = 0.
DO 270 I = 1,M
DO 270 J = 1,M
270 GG(I,J) = GG(I+1,J)
GO TÓ 20
EMD
224.
225.
227.
228.
229.
230.
231.
232.
233.
234.
236.
237.
238.
239.
239.
239.
241.
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JULY28
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SUBRØUT I NE PRINTV

| FORTRAN | MATH | CODE | DESCRIPTION | STORAG | | SUBBOUTIN | |
|---------|--------|------------|----------------------------------|--------------|------|--|--|
| SYMBOL | SYMBOL | | DESCRIPTION | BLOCK | LOC | SUBA COD | E VAR |
| KILO | | W Pounds | to kilogram conversion | /PRINTV/(+ | , | PRINTY W | K1L0 |
| KVBODY | | | vbody in mks units | /PRINTV/(+ | | PRINTY W | KABODA |
| KYCARG | | | vcargo in mks units | /PRINTV/(+ | | PRINTY W | KVCARS |
| KVCREW | | | vcrew in mks units | /PRINTY/(+ | | PRINTY W | KVCREW |
| KVFUTK | | | vfutk in mks units | /PRINTY/(+ | | PRINTY W | KVFUTK |
| KVFUT2 | | | vfutk2 in mks units | /PRINTV/(+ | | PRINTY W | KVFUT2 |
| KVINST | | W Same as | vinstk in mks units | /PRINTV/(+ | | PRINTY W | KVINST |
| KVLGBA | | W Same as | vigbay in mks units | /PRINTY/(+ |) | PRINTY W | KVLGBA |
| KVOTHE | | W Same as | vother in mks units | /PRINTV/(# |) | PRINTV W | KVOTHE |
| KVOXTK | | W Same as | voxtk in mks units | /PRINTV/(+ |) | PRINTY W | KVOXTK |
| KVOXT2 | | W. Same as | voxtk2 in mks units | /PRINTY/(+ |) | PRINTY W | KVOXT2 |
| KVPROP | | W Same as | vprop in mks units | /PRINT V/(+ |) | PRINTY W | KVPROP |
| KVSTRU | | ⊌ Same as | vstruc in mks units | /PRINTV/(+ |) | PRINTY W | KVSTRU |
| PRINTV | | E Subrout | ine to print vehicle volume data | /PRINTY/(\$ |) | PRINTY E
WTVOL S | PRINTV
PRINTV |
| PROTHR | | S Subrout | ine to print misc data | /PROTHR/(\$ |) | PRINTV S
PROTHR E | PROTHR
PROTHR |
| VBODY | | M Total bo | ody volume | /CINPUT/(| 391) | PRINTV M
SOLVE M
STORE M
TAMPER I
WTSCH M
WTVOL I | VBODY
VBODY
VBODY
VBODY
VBODY
VBODY |
| VCARGO | | I Volume | of cargo bay | /VOLCAL/(| 27) | PRINTV I
TAMPER I
WTSCH M | VCARGO
VCARGO
VCARGO |
| VCREW | | I Volume (| of cres compartment | /VOLCAL/(| 28) | PRINTV I
WTSCH M | VCREW
VCREW |
| VFUTK | | I Total ve | olume of fuel tank | /VOLCAL/(| 29) | PRINTV I
STORE M
TAMPER I
WTSCH M | VFUTK
VFUTK
VFUTK
VFUTK |
| VFUTK2 | | I Total vo | olume of secondary fuel tank | /volcal/(| 30) | PRINTV I
STORE M
TAMPER I
WTSCH M | VFUTK2
VFUTK2
VFUTK2
VFUTK2 |
| VINSTK | | 1 Total to | ank insulation volume | /VOLCAL/(| 31) | PRINTV I
WTSCH M | VINSTK
VINSTK |
| VLGBAY | | 1 Volume o | of recovery system bay | /VOLCAL/(| 32) | PRINTV I
WTSCH M | VLGBAY
VLGBAY |
| VOXTK | | I Total vo | riume of oxidizer tank | /VOLCAL/(| 34) | PRINTV I
STORE M
TAMPER I
WTSCH M | AOXIK
AOXIK
AOXIK |
| VOXTK2 | | I Total vo | lume of secondary oxidizer tank | /VOLCAL/(| 35) | PRINTY I
STORE M
TAMPER I
WTSCH M | VOXTK2
VOXTK2
VOXTK2
VOXTK2 |
| VPROP | | 'I Volume | f propulsion bay | /VOLCAL/(| 36) | PRINTY I
WTSCH M | VPROP
VPROP |
| VSTRUC | | I Volume o | f besic structure | /VOLCAL/(| 37) | PRINTY I
WTSCH M | VSTRUC
VSTRUC |

| FURTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | <u>ŞTORAGE</u>
Block loc | SUBHOUTING
Suba Code | USAGE
VAR |
|-------------------|----------------|-----------|-----------------|-----------------------------|----------------------------------|----------------------------|
| . UNO6 . | | O Flie of | ali output data | /.UND6./(\$ |) BLICO O
BNORYC O
CRASH O | . UNO6 .
. UNO6 . |
| | | | | | FRENCH O
FXDAT D | . UNO6. |
| | | | | | GEINP O
HUNT O
INEDIT O | . UNO6 |
| | | | | , | ITER8 0
MODELA 0 | . UNO6 |
| | | | | · | MOMJ O
MPSI O | . UNO 6 |
| | | | | | OUT O
PAYO2 O
PRINT O | . UNO6
. UNO6
. UNO6 |
| | | | | | PRINTY O
Printw o | . UNO 6 |
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| | | | | | PROPIN O
PROTHR O
PRWTSM O | . UNO 6 |
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| | | | | | SDINP O
SIZE O | . UNO6 |
| | | | | | SIZIN O
SIZOUT O
SOLVE O | . UNO6 |
| | | | | | SPLICO O
SPLIZ O | . UNO6 |
| • | | | | | SPLYNE O
SSSP O | . UN06 |
| | | | | | STAU 0
STPIT 0
SUMOUT 0 | . UNO 6 |
| | | | | | TABIN 0
TEST 0 | . UNO 6 |
| | | | | | VEHDF D
WTSCH D | . UNO6 |
| | | | | | MINOL 0 | . UNO 6 |

```
SUBROUTIME PRINTY

PRINTY -PRINTY VOLUMES

REAL LIO, KUSTRUL KUCARG, KVLGBA, KVPROP, KVFUTK, KVOXTK, KVINST, KVOTHE

(EAL SIA

REAL LIO, KUSTRUL KUCARG, KVLGBA, KVPROP, KVFUTK, KVOXTK, KVINST, KVOTHE

(EAL SIA

REAL LISP, LF, RR, MCREUL, LBDDY, NPASS

REAL MEMBERS

(EAL MEMBERS)

(LBDOY, CSBODY, CSFAIR, CSFUTK, CSHORZ, CSOXTK,

3CSPLAN, CSWERT, CSWING, CTHAST, CTHST2, OEF(5), FXUOUS,

3LSSPLAN, CSWERT, CSWING, CTHAST, CTHST2, OEF(5), FXUOUS,

3LSSPLAN, CSWERT, CSWING, CTHAST, CTHST2, OEF(5), FXUOUS,

4LSSPLAN, CSWERT, CSWING, CTHAST, CTHST2, OEF(5), FXUOUS,

3LSSPLAN, CSWERT, CSWING, CTHAST, CTHST2, OEF(5), FXUOUS,

4LSSPLAN, CSWERT, CSWING, CHAST, CTHST2, OEF(5), FXUOUS,

4LSSPLAN, CSWERT, CSWING, CHAST, CHAST, OEF(5), FXUOUS,

COMPORTAL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CALL, CAL
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C PRINTY - PP****
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F9.1,F1G.1) PAIN
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PRIM
    68.
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74.
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76. 100 FORMAT(1H0, 40HBDDY STRUCTURE
77. 200 FORMAT(1H, 40HCREW AND PASSENGER COMPARTMENTS 2F10.2) PRINTY
78. 300 FORMAT(1H, 40HCARGO COMPARTMENT 2F10.2) PRINTY
79. 400 FORMAT(1H, 40HLANDING GEAR BAYS 2F10.2) PRINTY
80. 500 FORMAT(1H, 40HPROPULSION BAY WITHIN BODY 2F10.2) PRINTY
81. 700 FORMAT(1H, 40HPROPULSION BAY WITHIN BODY 2F10.2) PRINTY
82. 800 FORMAT(1H, 40HDXIDIZER CONTAINERS 2F10.2) PRINTY
83. 900 FORMAT(1H, 40HDXIDIZER CONTAINERS 2F10.2) PRINTY
84. 1000 FORMAT(1H, 40HDXIDIZER CONTAINERS 2F10.2) PRINTY
85. 1400 FORMAT(1H, 40HDXIDIZER CONTAINERS 2F10.2) PRINTY
86. 1500 FORMAT(1H, 40HSECONDARY DXIDIZER CONTAINERS 2F10.2) PRINTY
86. 1500 FORMAT(1H, 40HSECONDARY DXIDIZER CONTAINERS 2F10.2) PRINTY
87. END
```

SUBRØUT I NE PRINTW

| ORTHAN
SYMBOL | MAIH
Symhol | CODE | DESCRIPTION | STORAG
BLOCK | LOC | SUBROUTING
SUBR CODE | F USAG |
|------------------|----------------|-----------------|---|--------------------------|-----|--|--|
| c | | I | Input array c(300) of vehicle sizing data | /CINPUT/(| 5) | PRINTW I PRITEQ I PRITVA I STORE M WISCH I WIVOL 0 | 000000 |
| FROST | | W | Wt of ice and frost (kg) | /PRINTW/(# | , | WTVOL O
Printw w | FROST |
| JUMP | | `1 | Data flag 0= orbiter 1= booster | /JUMPY /(| | FRENCH O
PRINTW I
PRITVA I
PRWTSM M
WTSCH I
WTVOL M | JUMP
JUMP
JUMP
JUMP
JUMP
JUMP |
| KILO | | 내 | Pounds to kilogram conversion | /PRINTW/(+ |) | PRINTW W | KILO |
| KOXTK2 | | W | Same as woxtk2 in mks units | /PRINTW/(+ |) | PRINTW W | KOXTK |
| KWABFT | | W | Same as wabftk in mks units | /PRINTW/(+ |) | PRINTW W | KWABF |
| WABPR | | 뉍 | Same as wabpr in mks units | /PRINTW/(+ |) | PRINTW W | KWABP |
| WACRE | | W | Same as wacres in mks units | /PRINTW/(* | .) | PRINTW W | KWACF |
| WACS | | 냂 | Same as wacs in mks units | /PRINTW/(+ |) | PRINTW W | KWACS |
| WACSF | | W | Smae as wacsfo in mks units | /PRINTW/(+ |) | PRINTW W | KWACS |
| WACST | | W | Same as wacstk in mks units | /PRINTW/(+ |) | PRINTW W | KWACS |
| WAERO | | u | Same as waero in mks units | /PRINTW/(* |) | PRINTW | KWAEF |
| TXUAW | | W | Same as wauxt in mks units | /PRINTW/(+ | | PRINTW W | KWAU |
| WBASI | | W | Same as mbasic in mks units | /PRINTW/(+ |) | PRINTW W | KWBAS |
| WBODY | | W | Same as whody in mks units | /PRINTW/(+ | | PRINTW W | KWBO |
| WCARG | | uj. | Same as meargo in mks units | /PRINTW/(+ | | PRINTW W | KWCAF |
| CMCOWW | | W | Same as ocomm in mks units | /PRINTW/(+ | | PRINTW W | KMCD |
| CWCONT | | laj | Same as woont in mks units | /PRINTW/(+ | | PRINTW W | KWCO |
| MCDAE | | W | Same as moover in mks units | /PRINTW/(+ | | PRINTW W | KWCO |
| WDECA | | W | Same as odecay in wks units | /PRINTW/(+ | | PRINTE W | KMDE(|
| (MDDCK | | ₩ | Same as wdock in mks units | /PRINTW/(+ | | PRINTW # | KW00(|
| (WDPLO | | tid
 | Same as mdploy in mks units | /PRINTW/(+ | | PRINTW W | KWCPt |
| WDRY | | W | Same as wdry in mks units | /PRINTW/(+ | | PRINTH W | KHORY |
| WELCA | | 0 | Same as melcad in mks units | /PRINTW/(+ | | PRINTW 0 | KMET |
| WENGS | | W | Same as wengs in mks units | /PRINTW/(+ | | PRINTW W | KWENS |
| WFAIR | | | Same as mfair in mks units | /PRINTW/(+ | - | PRINTW W | KWFAI |
| WFUL | | <u>14</u>
14 | Same as wful in mks units | /PRINTW/(+ | | PRINTW W | KWFUL |
| (WFULO
(WFUOX | | iii
Lii | Same as wfulos in mks units
Same as wfuox in mks units | /PRINTW/(+
/PRINTW/(+ | | PRINTW W
Printw w | KWFUE
KWFU8 |
| WFURE | | ᄖ | Same as migration was units | /PRINTW/(+ | | PRINTW W | KWFUR |
| WFUSY | | w | Same as afuses in mks units | /PRINTW/(+ | | PRINTW W | KWFUS |
| WFUTK | | w | Same as mrusys in mas units | /PRINTW/(+ | | PRINTW W | KWFUT |
| WFUTR | | พ | Same as wfutrp in mks units | /PRINTW/(+ | | PRINTW W | KWFUT |
| WFU2 | | w | Same as wfu2(1) in mks units | /PRINTW/(+ | | PRINTW W | KWFU2 |
| WGASP | | W | Same as mgaspr in mks units | /PRINTW/(+ | | PRINTW W | KWGAS |
| WGNAV | | W | Same as mynav in mks units | /PRINTW/(+ | | PRINTW W | KWGNA |
| WGROS | | ᄖ | Same as mgross in mks units | /PRINTW/(+ | | PRINTW W | KWGRO |
| WHORZ | | W | Same as whore in mks units | /PRINTW/(+ | | PRINTW W | KWHOF |
| WHYCA | | u u | Same as whycad in mks units | /PRINTW/(+ | | PRINTW W | KWHYC |
| WINFU - | | W | Same as winfut in mks-units | /PRINTW/(+ | | -PRI-NTWW | KWINF |
| X GN I W | | W | Same as winoxt in mks units | /PRINTW/(+ | | PRINTU W | KWIND |
| WINST | | w | Same as winstk in mks units | /PRINTW/(+ | | PRINTW W | KWINS |

| FORTIGAN MATH
SYMBOL SYMBOL | CODE DESCRIPTION | <u>SIOHANE SUBBOUTINE USA</u>
BLOOK LOO SUBB LOOE VA |
|--------------------------------|---|--|
| | | 001117111111111111111111111111111111111 |
| KWINSU | W. Same as minsul in mits units | /PRINTW/(*) PRINTW W KWIN |
| KWINS1 | W Same as winst in mks units | /PRINTW/(♥) PRINTW W KWIF |
| KWLANC | W Same as wlanch in mks units | /PRINTW/(*) PRINTW W KWL4 |
| KWLG | W Same as wig in mks units | /PRINTW/(#) PRINTW W KWLE |
| KWLOSS | W Same as wloss in mks units | /PRINTW/(#) PRINTW W KWL(|
| KWLRD | W Same as wird in mks units | /PRINTW/(+) PRINTW W KWLF |
| KWNACE | W Same as unacel in mks units | /PRINTW/(+) PRINTW W KWNA |
| KWOIL | W Same as woll in mks units | /PRINTW/(*) PRINTW W KWOJ |
| KWOILR | W Same as woilrs in mks units | /PRINTW/(+) PRINTW W KWOI |
| KWORSU | W Same as worsul in mks units | /PRINTW/(#) PRINTW W KWOF |
| KMOXID | W Same as moxid in mks units | /PRINTW/(#) PRINTW W KWO) |
| KWOXLO | W Same as woxlos in mks units | /PRINTW/(*) PRINTW W KWO) |
| KWOXRE | W Same as worres in mks units | /PRINTW/(#) PRINTW W KWO) |
| KWDXSY | W Same as moxsys in mks units | /PRINTW/(#) PRINTW W KWO) |
| KWOXTK | W Same as worth in mks units | /PRINTW/(#) PRINTW W KWO) |
| KWOXTR | W Same as moxtrp in mks units | /PRINTW/(#) PRINTW W KWOX |
| KWO X2 | W Same as wox2(1) in mks units | /PRINTW/(#) PRINTW W KWOX |
| KWPASS | W Same as wpass in mks units | /PRINTW/(→) PRINTW W KWPA |
| KWPAYL . | W Same as mpayl in mks units | /PRINTW/(+) PRINTW W KWPA |
| KWPERS | W Same as upers in mks units | /PRINTW/(#) PRINTW W KWPE |
| KWPOWC | W Same as wpowed in mks units | /PRINTW/(≠) PRINTW W KWPO |
| KWPOWE | W Same as upower in mks units | /PRINTW/(≠) PRINTW W KWPO |
| KWPOWF | W Same as upouto in mks units | /PRINTW/(≠) PRINTW W KWPO |
| KWPOWR | W Same as mpowrs in mks units | /PRINTW/(→) PRINTW W KWPO |
| KWPOWT | W Same as wpowtk in mks units | /PRINTW/(≠) PRINTW W KWPO |
| KWPPRO | W Same as upprovin mks units | /PRINTW/(≠) PRINTW W KWPP |
| KWPREI | W Same as opreig in mks units | /PRINTW/(≠) PRINTW W KWPR |
| KWPROP | W Same as uprop in mks units | /PRINTW/(≠) PRINTW W KWPR |
| KWPRSY | W. Same as uprsys in mks units | /PRINTW/(≠) PRINTW W KWPR |
| KWRESI | W. Same as wresid in mks units | /PRINTW/(+) PRINTW W KWRE |
| KWRESA | W. Same as presry in mks units | /PRINTW/(*) PRINTW W KWRE |
| KWSORC | W. Same as msorce in mks units | /PRINTW/(*) PRINTW W KWSO |
| KWSRTR | W. Same as wsrtrp in mks units | /PRINTW/(*) PRINTW W KWSF |
| KWSTAB | ₩ Same as østab in mks units | /PRINTW/(*) PRINTW W KWST |
| KWSURF | W Same as mourf in mks units | /PRINTW/(*) PRINTW W KWŞL |
| KWTHRS | W. Same as othrst in mks units | /PRINTW/(*) PRINTW W KWTH |
| KWTO | W. Same as mto in mks units | /PRINTW/(*) PRINTW W KWTO |
| KWTPS | W. Same as utps in mks units | /PRINTW/(≠) PRINTW W KWTP |
| KWVERT | W Same as overt in mks units | /PRINTW/(*) PRINTW W KW∀E |
| KWWET | ₩ Same as muet in mks units | /PRINTW/(≠) PRINTW W KWWE |
| KWWING | ₩ Same as uming in mks units | /PRINTW/(≠) PRINTW W KWWI |
| PLOLOS | W Payload loss (lb) input as c(296) | /PRINTW/(≠) PRINTW W PLDL |
| PLLOS | W Same as pidios in mks units | /PRINTW/(#) PRINTW W PLLO |
| PRINT | E Subroutine to print vehicle meight data | /PRINTW/(\$) PRINTW E PRIN
WIVOL S PRIN |
| WABFIK | I Weight of air breathing propulsion system tan | WISCH M WABF |
| WABFU | I Weight of jpfuel | /WTCALC/(3) PRINTW I WABR
PRWTSM M WABR
TAMPER I WABR
WTSCH M WABR |

| | | MATH. | | | STORAGE SUBROUTINE USAG | | | |
|--------------|----------------|--|-----------------|-----------|---------------------------------|----------------------------|--|--|
| SYMAUL - | MATH
SYMBOL | CODE DESCRIPTION | STORA:
BLOCK | GE
LOC | SUBBOUTING
SUBB COOK | | | |
| WABPR | | I Weight of air breathing engines | /WTCALC/(| 4) | PRINTW I
WTSCH M | WABPR
Wabpr | | |
| WACRES | | I Weight of attitude control fuel reserve | /WTCALC/(| 5) | PRINTW I
STORE M
WTSCH M | WACRES
WACRES | | |
| WACS | | I Weight of attitude control system | /WTCALC/(| 6) | PRINTW I
WTSEH M | WACS
WACS | | |
| WACSFO | |] Weight of attitude control fuel plus oxidizer | /WTCALC/(| 7) | PRINTW I
STORE M
WTSCH M | WACSFO
WACSFO
WACSFO | | |
| WACSTK | |] Weight of attitude control tankage | /WTCALC/(| 8) | PRINTW I
WTSCH M | WACSTK
WACSTK | | |
| WAERO | | I Weight of aerodynamic controls | /WTCALC/(| 9) | PRINTU I
WTSCH M | WAERD
Waerd | | |
| TXUAW | | [Weight of separation system , | /WTCALC/(| 10) | PRINTW I
STORE I
WTSCH M | TXUAW
TXUAW
TXUAW | | |
| WBAS1C | | I Total meight of basic body | /WTCALC/(| 11) | PRINTW 1
PROTHR I
WTSCH M | WBASIC
WBASIC
WBASIC | | |
| WBODY | | I Total meight of body group | /WTCALC/(| 12) | PRINTW I
WTSCH M | M80DA | | |
| 4800 | | 1 Booster gross weight | /JUMPY /(| 3) | PRINTW 1
TAMPER 1
WTVOL 0 | ₩800
₩800 | | |
| WCAR GD | |] Pavload meight or cargo | /WTCALC/(| 14) | PRINTW I
WTSCH M | WCARGO
WCARGO | | |
| MEONM | |] Communication system weight | /WTCALC/(| 15) | PRINTW I
WTSCH M | MMG3W
Mmg3W | | |
| WCONT | | I Contingency and growth weight | /WTCALC/(| 16) | PRINTW I
TAMPER I
WTSCH M | MCONT
WCONT
WCONT | | |
| WC0 VER | | I Total weight of thermal protection system cover panels | /WTCALC/(| 17) | PRINTW I
WTSCH M | WCOVER
WCOVER | | |
| WDECAY | | I Thrust decay propellant meight | /WTCALC/(| 18) | PRINTW I
STORE M
WTSCH M | WDECAY
WDECAY
WDECAY | | |
| MDOCK | | I Docking structure meight | /WTCALC/(| 21) | PRINTW I
WTSCH M | MDOCK
MDOCK | | |
| WDPLOY | | I Deployable aerodynamic device meight | /WTCALC/(| 22) | PRINTW I
WTSCH M | MDPL04 | | |
| WDRY | | I Stage dry seight | /WTCALC/(| 24) | PRINTH I
TAMPER I
WTSCH M | MDRY
MDRY
MDRY | | |
| WENGS | | I Weight of rocket engines installed | /WTCALC/(| 28) | PRINTW I
WTSCH M | WENGS | | |
| WENGS2 | | [Weight of secondary engines | /WTCALC/(| 29) | PRINTW I
WTSCH M | WENGS2
WENGS2 | | |
| WFAIR | | I Weight of fairings and shrouds | /WTCALC/(| 30) | PRINTW I
WTSCH M | WFAIR
WFAIR | | |
| WFROST | | I Frost and ice meight | /WTCALC/(| 33) | PRINTW I
STORE M
WTSCH M | WFROST
WFROST
WFROST | | |
| WFUL | | [Fuel meight | /WTCALC/(| 431 | PRINTW I
WTSCH M | WFUL
WFUL | | |
| WFULOS | | I Vented fuel | /WTCALC/(| 44) | PRINTW I | WFULOS
WFULOS
WFULOS | | |

| EGILLEAN
SYMBOL | MAIH
54MHUL | 0001 | DESCRIPTION | <u>Storas</u>
Blû K | <u> </u> | SUBBRICE SUBBRICE | |
|--------------------|----------------|------|---|------------------------|----------|--|--|
| 24,100. | 3111100 | | | 750 4 | | 308N COL | - |
| WFUOX | | I | Weight of main and secondary propellant | /WTCALC/(| 46) | PRINTW I
TAMPER I
WTSCH M
WTVOL I | WFUOX
WFUOX
WFUOX
WFUOX |
| WFURES | | I | Fuel reserve | /WTCALC/(| 47) | PRINTW I
STORE M
TAMPER I
WTSCH M | WFURES
WFURES
WFURES
WFURES |
| WFU5YS | | 1 | Total fuel system #eight | /WTCALC/(| 48) | PRINTW I
WTSCH M | WFUSYS
WFUSYS |
| WFUTK | | I | Wt of non-structural fuel tankage | /WTCALC/(| 49) | PRINTW I | WFUTK |
| WFU1K2 | | I | Wt of secondary fuel tank and system | /WTCALC/(| 50) | PRINTW I | WFUTK2 |
| WFUTRP | | 1 | Trapped fuel meight | /WTCALC/(| 52) | PRINTW I
STORE M
WTSCH M | WFUTRP
WFUTRP
WFUTRP |
| WFU2 | | I | Weight of secondary fuel | · /WTCALC/(| 34) | PRINTW I
TAMPER I
WTSCH M | WFU2
WFU2,
WFU2 |
| WGASPR | | Ī | Weight of gas and pressurant | /WTCALC/(| 53) | PRINTW I
STORE M
WTSCH M | WGASPR
WGASPR
WGASPR |
| WGNAV | | 1 | Guidance and navigation system at | /WTCALC/(| 54) | PRINTW I
WTSCH M | WGNAV
WGNAV |
| WGROSS | | I | Gross lift-off meight | /CINPUT/(| 392) | PRINTW I
PRWTSM I
SOLVE M
STORE M
TAMPER I
WTSCH M
WTVOL I | WGROSS
WGROSS
WGROSS
WGROSS
WGROSS
WGROSS |
| WHORZ | | I | Horizontal stabilizer et. | /WTCALC/(| 55) | PRINTW I
PROTHR I
WTSCH M | WHORZ
WHORZ
WHORZ |
| MHYCAD | | 1 | Hydraulic / pneumatic system mt | /WTCALC/(| 56) | PRINTW 1
WTSCH M | WHY CAD |
| WINFUT | | 1 | Weight of intergral fuel tank | /WTCALC/(| 57) | PRINTW I
PROTHR I
WTSCH M | WINFUT
WINFUT
WINFUT |
| MINOXT | | 1 | Weight of integral oxidizer tank | /WTEALC/(| 58) | PRINTW I
PROTHR I
WTSCH M | TXGNIW
TXGNIW
TXGNIW |
| WINST | | 1 | Weight of instrument system | /WTCALC/(| 60) | PRINTW I
WTSCH M | WINST
Winst |
| WINSTK | | 1 | Total seight of tank insulation | /WTCALC/(| 59) | PRINTW I
WTSCH M | WINSTK
WINSTK |
| WLANCH | | I | Launch gear weight | /WTCALC/(| 68) | PRINTW I
WTSCH M | |
| WLG | | 1 | Landing gear and controls meight | /WTCALC/(| 69) | PRINTW I
WTSCH M | WLG
WLG |
| ₩Ł0\$\$ | | 1 | In-flight weight loss | /WTCALC/(| 70) | PRINTW I
PRWTSM I
WTSCH O | WLOSS
WLOSS |
| WLRD | | 1 | Launch and recovery system melght | /WTCALC/(| 71) | PRINTW I
WTSCH M | WLRD
WLRD |
| WNACEL | | 1 | Pylons, nacel, and pod meights | /WTCALC/(| 723 | PRINTW I
WTSCH M | WNACEL |
| MO1 r | | Ţ | Service Item losses | /WT_CALC/(| _ 74) | | WOIL _ |
| WOILRS | | 1 | Service item reserves | /WTCALC/(| 75) | PRINTW 1
WTSCH M | WOILRS |

| FORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | V STORAG | E SUBHOUTINE USAGE |
|-------------------|----------------|--|-------------------------|---|
| | J 1 100 C | | 5000 | 100 000 100 |
| WORSUL | | I Orientation, control, and separation | system weight /WTCALC/(| 76) PRINTW I WORSUI
WTSCH M WORSUI |
| M0 X 1 0 . | | I Main impulse oxidizer meighter | /WTCALC/(| 87) PRINTW I WOXID
WISCH M WOXID |
| WOXLOS | | I Vented oxidizer | /WTCALC/(| 88) PRINTW I WOXLOS
STORE M WOXLOS
WTSCH M WOXLOS |
| WOXRES | | I Oxidizer reserve | /WTCALC/(| 89) PRINTW I WOXRES STORE M WOXRES TAMPER I WOXRES WTSCH M WOXRES |
| WOXSYS | | I Oxidizer system meight | /WTCALC/(| 90) PRINTW I WOXSY!
WTSCH M WOXSY! |
| MO XTK | | I Non-sturctural tank #t oxidizer | /WTCALC/(| 91) PRINTW I WOXTK
WTSCH M WOXTK |
| WDXTK2 | | I Secondary system oxidizer tank #t , | /WTCALC/(| 92) PRINTW I WOXTK |
| WO XTRP | | I Trapped oxidizer weight | /WTCALC/(| 94) PRINTW I WOXTRI
Store m woxtri
Wtsch m woxtri |
| ₩0 X 2 | | I Secondary oxidizer meight | /WTCALC/(| 84) PRINTW I WOX2
TAMPER I WOX2
WTSCH M WOX2 |
| WP ASS | | 1 Weight of passengers | /WTCALC/(| 96) PRINTW I WPASS
WTSCH M WPASS |
| WPAYL | | I Payload meight | /WTCALC/(| 97) PRINTW I WPAYL
TAMPER I WPAYL
WTSCH M WPAYL |
| WPERS | | I Crem gear and life support meight | /WTCALC/(| 98) PRINTW I WPERS
WTSCH M WPERS |
| MPDMCD | | 1 Power conditioning equipment wt. | /WTCALC/(| 99) PRINTW I WPOWCE
WTSCH M WPOWCE |
| WPOWFO | | I Power system propellant wt. | /WTCALC/(| 101) PRINTW I WPOWFO
STORE M WPOWFO
WISCH M WPOWFO |
| WPOWRS | | I Power system propellant reserve | /WTCALC/(| 102) PRINTW I WPOWRS
STORE M WPOWRS
WTSCH M WPOWRS |
| MPOWTK | | 1 Prime power system tank weight | /WTCALC/(| 103) PRINTW I WPOWTI
WTSCH M WPOWTI |
| WPPROV | | I Personnel provisions | /WTCALC/(| 104) PRINTU I WPPROW
WTSCH M WPPROW |
| WPREIG | | I Pre-ignition losses | /WTCALC/(| 105) PRINTW I WPREIG
PRWTSM M WPREIG
WTSCH M WPREIG |
| WPROP | | I Total weight- propulsion group | /WTCALC/(| 106) PRINTW I WPROP
WTSCH M WPROP |
| ⊎PRSYS | | I Pressurization system meight | /WTCALC/(| 107) PRINTW I WPRSYS
WTSCH M WPRSYS |
| JRESID | | I Weight of residuals | /WTCALC/(| 109) PRINTW I WRESIC WTSCH M WRESIC |
| JRESRV | | I Propeliant reservs | /WTCALC/(| 110) PRINTW I WRESRY
WTSCH M WRESRY |
| WSECST | | I Secondary body structure mt | /WTCALC/(| 112) PRINTW I WSECST PROTHR I WSECST WTSCH M WSECST |
| WSORCE | | I Prime power system weight | /WTCALC/(| 113) PRINTW I WSORCE
WTSCH M WSORCE |
| WSATRP | | I Trapped oxidizer meight | /WTCALC/(| 1149 PRINTW I WSRTRP
STORE M WSRTRP
WTSCH M WSRTRP |

| FORTHAN MAIN | CODE DESCRIPTION | STORAGE | SURROUTINE USAGE |
|--------------|---------------------------------------|----------------|---|
| SYMBOL SYMBO | F OF SCHILLION | BLULK LOC | SUBR CODE VAR |
| U.C.T.A.B. | f Paulas alakat amakan ak | (),TCA(C// | COLUZIO I LICTAD |
| WSTAB | I Engine glabal system mt | /WTCALC/(115) | PRINTW I WSTAB
WTSCH M WSTAB |
| WSURF | 1 Aero surface wt | /WTCALC/(116) | PRINTW I WSURF |
| WTHRST | I Thrust structure mt | /WTCALC/(118) | PRINTW I WTHRS |
| wT0 | I Take- off weight | /WTCALC/(119) | PRINTW 1 WTO
WTSCH M WTO |
| WTPS | I Induced environmental protection at | /WTCALC/(120) | PRINTW I WTPS
WTSCH M WTPS |
| WVERT | 1 Vertical fin meight | /WTCALC/(121) | PRINTW I WVERT PROTHR I WVERT WISCH M WVERT |
| WWET | I Operating weight-empty | /WTCALC/(132) | PRINTW I WWET |
| WWING | I Total structural mt. Of ming | /WTCALC/(133) | PRINTH I WHING PROTHR I WHING HTSCH M WHING |
| . UNO 6 . | O File of all output data | /.UN06./(\$) | BLICO |

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        13.
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, WEMPTY
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WPOWCO
WPROP
WSORCE
WTPS
WABRES
WPWOTP
WPWFRS
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68.
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71.
72.
73.
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88:1

| 151
152 | 26 FORMAT (1H0,31HWEIGHT BREAKDOWN - BOOST STAGE ,33X6HPOUNDS
• 9HKILOGRAMS) | 5,20X PRINTW
PRINTW |
|--------------|---|------------------------|
| 153. | | PRINTW |
| 154. | 50 WRITE(6,100) WSURF,KWSURF
150 WRITE(6,200) WWING,KWWING | PRINT |
| 155. | 250 WRITE (6,13500) WHORZ,KWHORZ | PRINTU
Printu |
| 156.
157. | 350 WRITE(6,400)WVERT,KWVERT | PRINTU |
| 158. | 650 WRITE(6,700)WFAIR,KWFAIR
750 WRITE(6,800)WBDDY,KWBDDY | PRINTW |
| 159. | | PRINTH |
| 160. | WRITE(6,900) WINFUT, KWINFU
Write(6,1000) Windxt, kwindx | PRINT |
| 161.
162. | 1050 WRITE(6,1100)WBASIC,KWBASI
WRITE(6,1300) WSECST,KWSECS | PRINTU
Printu |
| 163. | WRITE(6,1300) WSECST KWSECS
1350 WRITE (6,1400) WTHRST, KWTHRS
1550 WRITE(6,1600) WTHRST, KWTPS | PRINTU |
| 164. | 1550 WRITE(6,1600) WTPS, KWTPS | PRINTЫ |
| 165. | 1750 WRITE(6,1800) WCOVER,KWCOVE | PRINTU |
| 166. | 1850 WRITE(6,1900) WINSUL, KWIMSU | PRINTW :
Printw : |
| 167. | 2150 WRITE(6,2200)WLRD,KWLRD
2250 WRITE(6,2300)WLANCH ,KWLANC | PRINTE |
| 169. | 2350 WAITE(6,2400) WOPLOY, KMDPLO | PRINTU |
| 170. | 2450 WRITE(6,2500) WLG.KWLG | PRINTU |
| 171. | 2550 WRITE(6,2600) WDOCK,KWDOCK | PRINT |
| 172. | 2/50 WKITE(6,2800) WPRUP,KWPRUP | PRINTW
Printw |
| 173.
174. | 2850 WRITE(6,2900) WENGS, KWENGS
WRITE(6,2870) WENGS2, KWENG2 | PRINTE |
| 175. | WRITE(6,3300) WEUTK, KWEUTK | PRINTU |
| 176. | WRITE(6,3400) WOXTK,KWOXTK
Write(6,3410) Wfutk2,Kfutk2 | PRINTH |
| 177. | WRITE(6,3410) WFUTK2,KFUTK2 | PRINTW
Printw |
| 178.
179. | WRITE(6,3420) WOXTK2,KOXTK2
WRITE(6,3500) WINSTK,KWIMST
3550 WRITE(6,3600) WOXSVS,KWOXSV
WRITE(6,3700) WOXSVS,KWOXSV | PRINTW |
| 180. | 3550 WRITE(A 3A00) WEUSYS KWEUSY | PRINTW |
| 181. | WRITE(6,3700) WOXSVS,KWOXSY | PRINTU |
| 182. | MMITELD, 3000) MPMSTS, ROPMST | PRINTW |
| 183. | WRITE(6,4110) WABPR, KWABPR | PRINTU
Printu |
| 184.
185 | WRITE(6,3100) WNACEL,KWNACE
WRITE(6,4115) WABFTK,KWABFT | PRINTU |
| 186. | 4250 WRITE(6,4300)MORSUL KWORSU | PRINTW ! |
| 187. | 4250 WRITE(6,4300) WORSUL KWORSU
4350 WRITE(6,4400) WAUXT KWAUXT
WRITE(6,4470) WSTAB KWSTAB | PRINTW |
| 188. | WRITE(6,4470) WSTAB, KWSTAB | PRINTW PRINTW |
| 189.
190. | 4450 WKIIE(6.4500) WAERU.KWAERU | PRINTU |
| 191. | 4550 WRITE(6,4600) WACS,KWACS
WRITE(6,4800) WACSTK,KWACST | PRINTE |
| 192. | 4850 WRITE(6,4900)WPOWER,KWPOWE | PRINTW |
| 193. | 4950 WRITE(6,5000) WSDRCE,KWSDRC | PRINTW |
| 194. | WRITE(6,5300) WPONTK, KWPONT | PRINTW
Printw |
| 195.
196. | 5350 WRITE (6,5400)WPOWCD,KWPOWC
5550 WRITE(6,5600)WHYCAD,KWHYCA | PRINT |
| 197. | 5650 WRITE(6,5700) WENAV, KWENAV | PRINTW |
| 198. | 5750 WRITE(6,5800) WINST,KWINS1 | PRINTU |
| 199. | 5850 WRITE(6.5900) WCDAM,KWCDAM | PRINTW PRINTW |
| 200.
201. | 6550 WRITE(6,6600)WPPRDV,KWPPRD
7250 WRITE(6,7300) WDRY,KWDRY
WRITE(6,7300) WCONT,KWCONT | PRINTU |
| 202. | WRITE(6.7400) WCDNT.KWCONT | PRINTE |
| 203. | /45U WHITE(6./500) WPEHS.KWPEHS | PRINTH |
| 204. | 7750 WRITE(6,7800) WPAYL .KWPAYL | PRINTU |
| 205. | 7851 WRITE (6,7900) WPASS, KWPASS | PRINTW PRINTW |
| 206.
207. | WRITE (6,7860) WCARGO, KWCARG
8350 WRITE(6,8400)WRESID,KWRESI | PRINTU |
| 208. | WRITE(6.8500) WGASPR.KWGASP | PRINTH (|
| 209. | 8550 WRITE(6,8600)WFUTRP.KWFUTR | PRINTW |
| 210. | WRITE(6.8700) WOXTRP.KWOXTR | PRINTЫ
Printы |
| 211.
212. | 8850 WRITEL 6, 8900 JUSETRP, KUSETR
8950 WRITEL 6, 9000 JURESRY, KURESR
9050 WRITEL 6, 9100 JUFURES, KUFURE | PRINTW |
| 213. | 9050 WRITE(6,9100)WEURES, KWEURE | PRINTU |
| 214. | WKITE(6,7200) WOXKES,KWOXKE | PRINTW |
| 215. | WRITE(6,9300) WPDWRS,KWPOWR | PRINTU |
| 216. | WRITE(6,9400) MOILRS,KWOILR | PRINTW
Printw |
| 217.
218. | WRITE(6,9500) WACRES, KWACRE
9650 WRITE(6,9700) WWET KWWET | PRINTW |
| 219. | 9650 WRITE(6,9700) WWET KWWET
9750 WRITE(6,9800) WW.055 KWLOSS | PRINTW |
| 220. | | PRINT |
| 221. | WRITE(6,9898) WFROST, FROST | PRINTW PRINTW |
| 222
223. | WRITE(6,9898) WFROST FROST
9850 WRITE(6,9900)WFULDS, KWFULD
9950 WRITE(6,10000)WGULDS, KWGULD | PRINT |
| 224. | 10050 WRITE(6,10100)MPOWFO,KWPOWF | PRINTW |
| | | PRINTW |

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WRITE(6,10400) WOIL, KWDIL
WRITE(6,10410) WABFU, KWABFU
WRITE(6,10600) WDECAY KWDECA
10650 WRITE(6,10800) WFUL, KWFUUX
WRITE(6,11400) WOXID, KWDVID
WRITE(6,11400) WOXID, KWDVID
WRITE(6,11500) WDX12(1) KWDVIZ
WRITE(6,11500) WTO KWTO
WRITE(6,11500) WTO KWTO
WRITE(6,12300) WPRIG, KWPREI
WRITE(6,12300) WPRIG, KWPREI
WRITE(6,12300) WRROSS, KWGROS
IF(JUMP,EEO.0) GO TO 9999
KWB00 = WB00 + KILO
WRITE(6,13010) WB00 , KWB00
226.
227.
228.
229.
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PRINTU
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  230.
 231.
232.
233.
234.
235.
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 236.
237.
238.
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                                                                                                                                                                                                                                                                                                                                                                                      PRINTU
PRINTU
                           999 CONTINUE
RETURN
100 FORMAT(1HO 52HAERODYNAMIC SURFACES
*F18.0,F27.0 )
200 FORMAT(1H, 52H WING + WING MOUNT
*F9.0,F27.0)
400 FORMAT(1H, 52H VERTICAL SURFACES
240.
241.
242.
243.
244.
245.
246.
247.
248.
                                                                                                                                                                                                                                                                                                                                                                                      PRINTH
                                                                                                                                                                                                                                                                                                                                                                                       PRINTW
PRINTW
                     *F9.0,F27.0)

400 FORMAT(1H ,52H VERTICAL SU +59.0,F27.0)

700 FORMAT(1H ,52H FAIRINGS,SH *F9.0,F27.0)

800 FORMAT(1H ,52H FAIRINGS,SH *F9.0,F27.0)

900 FORMAT(1H0,52HBODY STRUCTURE *F18.0,F27.0)

1000 FORMAT(1H ,50H STRUCTURAL *F11.0,F27.0)

1100 FORMAT(1H ,52H BASIC BODY S *F9.0,F27.0)

1300 FORMAT(1H ,52H SECONDARY ST *F9.0,F27.0)

1400 FORMAT(1H ,52H THRUST STRUCTURAL *F9.0,F27.0)

1400 FORMAT(1H ,52H THRUST STRUCTURAL *F9.0,F27.0)
                                                                                                                                              WING + WING MOUNTED CONTROL SURFACES
                                                                                                                                                                                                                                                                                                                                                                                      PRINTW
PRINTW
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                                                                                                                                              VERTICAL SURFACES
                                                                                                                                              FAIRINGS, SHROUDS AND ASSOCIATED STRUCTURE
                                                                                                                                                                                                                                                                                                                                                                                       PRINTW
PRINTW
PRINTW
PRINTW
                                                                                                                                                  STRUCTURAL FUEL CONTAINERS
 253.
254.
255.
256.
                                                                                                                                                  STRUCTURAL OXIDIZER CONTAINERS
                                                                                                                                                                                                                                                                                                                                                                                       PRINTW
PRINTW
PRINTW
PRINTW
                                                                                                                                              BASIC BODY STRUCTURE
                        **F9.0,F27.0)

1300 FORMÁT(1H, 52H SECONDARY STRUCTURE

**F9.0,F27.0)

1600 FORMÁT(1H, 52H THRUST STRUCTURE

**F9.0,F27.0)

1600 FORMÁT(1H, 52H THRUST STRUCTURE

**F9.0,F27.0)

1800 FORMÁT(1H, 52H COVER PANELS,NON-STRUCTURAL

**F18.0,F27.0)

1900 FORMÁT(1H, 52H VEHICLE INSULATION

**F9.0,F27.0)

2000 FORMÁT(1H, 52H LAUNCH, RECOVERY AND DOCKING

**F18.0,F27.0)

2400 FORMÁT(1H, 52H DEPLOYABLE AERODYNAMIC DEVICE:

**F9.0,F27.0)

2500 FORMÁT(1H, 52H DOCKING STRUCTURE

**F9.0,F27.0)

2500 FORMÁT(1H, 52H DOCKING STRUCTURE

**F9.0,F27.0)

2600 FORMÁT(1H, 52H DOCKING STRUCTURE

**F9.0,F27.0)

2800 FORMÁT(1H, 52H DOCKING STRUCTURE

**F9.0,F27.0)

2800 FORMÁT(1H, 52H DOCKING STRUCTURE

**F9.0,F27.0)

2900 FORMÁT(1H, 52H SECONDARY ENGINES AND ACCESSOI

**F9.0,F27.0)

3100 FORMÁT(1H, 52H NACELLES,PODS,PYLONS,SUPPORTS

**F9.0,F27.0)

3100 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SUPPORTS

**F9.0,F27.0)

3400 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SYS

**F9.0,F27.0)

3400 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SYS

**F9.0,F27.0)

3400 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SYS

**F9.0,F27.0)

3400 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SYS

**F9.0,F27.0)

3400 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SYS

**F9.0,F27.0)

3400 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SYS

**F9.0,F27.0)

3500 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SYS

**F9.0,F27.0)

3500 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SYS

**F9.0,F27.0)

3500 FORMÁT(1H, 52H SECONDARY FUEL TANKAGE AND SYS

**F9.0,F27.0)

3600 FORMÁT(1H, 52H SECONDARY SYSTEM - MAIN

**F9.0,F27.0)

3600 FORMÁT(1H, 52H SYSTEM - MAIN

**F9.0,F27.0)

3600 FORMÁT(1H, 52H SYSTEM - MAIN

**F9.0,F27.0)

3600 FORMÁT(1H, 52H SYSTEM - MAIN

**F9.0,F27.0)
                                                                                                                                              SECONDARY STRUCTURE
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PRINTW
PRINTW
  260.
  261
262.
263.
264.
265.
266.
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 268
269
270.
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271.
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273.
274.
275.
276.
277.
                                                                                                                                               DEPLOYABLE AERODYNAMIC DEVICES
                                                                                                                                                                                                                                                                                                                                                                                       PRINTU
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279.
280.
281.
282
283.
284.
285.
                                                                                                                                               SECONDARY ENGINES AND ACCESSORIES
                                                                                                                                                                                                                                                                                                                                                                                       PRINTW
PRINTW
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  286.
287
288.
                                                                                                                                              FUEL CONTAINERS AND SUPPORTS (NON-STRUCTURAL)
                                                                                                                                                                                                                                                                                                                                                                                       PRINTE
                                                                                                                                              DXIDIZER CONTAINERS AND SUPPORTS(NON-STRUCTURAL)
                                                                                                                                               SECONDARY FUEL TANKAGE AND SYSTEMS
                                                                                                                                                                                                                                                                                                                                                                                       PRINTH
                                                                                                                                              SECONDARY OXIDIZER TANKAGE AND SYSTEMS
  293.
294.
295.
                                                                                                                                                                                                                                                                                                                                                                                        PRINTH
                                                                                                                                                                                                                                                                                                                                                                                       PRINTW
PRINTW
PRINTW
 296.
297.
298.
299.
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PRINTW
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5

SUBRØUT I NE PRITEQ

| FORTRAN | MATH | CODE | DESCRIPTION | STORA | GE . | SUARQUIIN | E USAGE |
|---------|--------|-----------|-------------------------------------|-----------|------------|--|---|
| SYMBOL | SYMBOL | | DESCRIPTION | BLUEK | LÜÜ | SUBR COD | L VAR |
| c | | 1 Input | array c(300) of vehicle sizing data | /C1NPUT/(| 5) | PRINTW 1 PRITEG 1 PRITVA 1 STORE M WISCH 1 WIVOL 0 | C C C C C C C |
| 1 | | W Co loop | p counter | /PRITEQ/(| +) | PRITEO W | 1 |
| . UN06. | | | f all output data | /.UNO6./(| | BLICOY C O O CRASH O O O CRASH O O CRASH O O CRASH O O CRASH O O CRASH O O O CRASH O O O CRASH O O O CRASH O O O CRASH O O O CRASH O O O O CRASH O O O O CRASH O O O O CRASH O O O O CRASH O O O O CRASH O O O O O CRASH O O O O O O CRASH O O O O O O CRASH O O O O O O CRASH O O O O O O O CRASH O O O O O O O CRASH O O O O O O O CRASH O O O O O O O O O O O O O O O O O O O | . UNO66 U |

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PRITED
PRITED
PRITED
PRITED
SIZING
SIZING
                                                                                                                                                                                                                                 SUBROUTINE PRITES
               1.
2.
3.
4.
5.
6.
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C
C
                                                                                                                                                                                            SUBROUTINE TO PRINT WEIGHT AND VOLUME
REAL MUB. MUO. ISPB, ISPO, IDVEL, NNB, NO
COMMON / SIZING/
PHASE II SIZING PARAMERERS

*TZ. VV(3), QP(14), EROR, PZ
*SV(28), SQ(37,5), SE(11), TLAT. T
PHASE II SIZING PARAMERERS
*WBO, BLOD, DWEB, DWEO, T
*BK1, OK2, BK3, BK4, II
*BK1, OK2, BK3, BK4, II
*BK1, TVACO, NO, WFO, II
*AKXIT, TVACO, NO, WFO, II
*SVOP, DVB, MUB, MUO,
*STOP, BEO, BSTG, ORBI IT
*SVOPSQ, SVOCON, IHUNT, IOPSTG, IS
REAL KIN
REAL ISP, KLF, MR, NCREW, LBODY, NPASS
REAL NENGS
COMMON/CINPUT/
1ANENGS, ANTANK, ASRATO, ASWEEP
3CSPLAN, CSVERT, CSWING, CTHRST, CTHS
*MISP(6), ITPS, K(30), KIN
*SPENGS, NLISTO, NPASS, NWL, PCHA
*MISP(6), TYPS, K(30), KIN
*SPENGS, NLISTO, NPASS, NWL, PCHA
*GROUPY, LBODY, LBODY, CROOT, CSPAN, CTP
ZNBODY, LBODY, RGODS, COMMON/VOLCAL/BBODY, CROOT, CSPAN, CTP
ZNBODY, LBODY, RGOD, SPAN, SPOC
SYCREW, VFUTK, VFUTK2, VRODYA, WBOD
*SYCREW, VFUTK, VFUTK2, WASFTK, WABF
*MACS, WACSFO, WACSTK, WAERO, WACSTA
                                                                                                                                                                                                                                                                                                            SUBROUTINE TO PRINT WEIGHT AND VOLUME COEFFICIENTS
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IPSMAX, SIZING
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BERNO, SIZING
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TRAFLG,
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COMMON/WTCALC/ ABFSYS
1WACS WACSFO WACSTK
2WBPUMP WCARGO WCOMM
3WD1STZ WDDCK WDPLOY
4WENGMT WENGS WENGS2
5WFUZ(3) WFUEL(6) WFUL
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MMNFTP
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SUBRØUT I NE PRITVA



| ORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAGE
BLOCK LOC | SUBROUTIA
SUBR COO | E USAG |
|------------------|----------------|---------------|---------------------------------|----------------------|---|--|
| 3141801 | 3111801 | | | BLUCK CUC | 308N C00 | E VAN |
| c
, | | i input arra | y c(300) of vehicle sizing data | /C1WPUT/(5 |) PRINTW I
PRITEQ I
PRITVA I
STORE M
WTSCH I
WTVOL O | 000000 |
| CBBODY | | I Body midth | coeff. | /CINPUT/(305 |) PRITVA I
STORE M
WTSCH I | CBBOD
CBBOD
CBBOD |
| CHBOBY | | I Body height | t or coeff | /CINPUT/(312 |) PRITVA I
STORE M
WISCH I | CHBOD
CHBOD
CHBOD |
| CLBODY | | I Body length | n or coeff | /CINPUT/(313 |) PRITVA I
STORE M
WTSCH I | CLB00'
CLB00'
CLB00' |
| SBODY | | I Total body | metted area or coeff | /CINPUT/(314 |) PRITVA I
STORE M
WTSCH I | C\$800°
C\$800°
C\$800° |
| SFAIR | | 1 Fairing pla | enform area or coaff | /CINPUT/(315 |) PRITVA I
STORE M
WTSCH I | CSFAIR
CSFAIR
CSFAIR |
| SFUTK | | I Fuel tank s | surface area or coeff | /CINPUT/(316 |) PRITVA I
STORE M
WTSCH I | CSFUTI
CSFUTI
CSFUTI |
| SHORZ | ` | I Horizontal | stabalizer planform area | /CIMPUT/(317 |) PRITVA 1
STORE M
WTSCH I | CSHOR
CSHOR
CSHOR |
| SOXTK | | 1 Ozidizer ta | nk surface area coeff | /CINPUT/(318 |) PRITVA I
STORE M
MTSCH I | CSOXT
CSOXT
CSOXT |
| SPLAN | | 1 Body planfo | re area or coeff | /CINPUT/(319 |) PRITVA I
STORE M
WTSCH I | CSPLAI
CSPLAI
CSPLAI |
| SVERT | | I Vertical fi | n planform area or coeff | /CINPUT/(320 | PRITVA I
STORE M
WTSCH I | CS VERT |
| THRST | | 1 Vec. Thrus | t-to-meight ratio | /CINPUT/(322 | PRITVA I
STORE M
WTSCH I
WTVOL M | CTHRS1
CTHRS1
CTHRS1
CTHRS1 |
| THST2 | | I Secondary p | rapulsion t/s | /CIMPUT/(323 | PRITVA I
STORE M
WISCH I | CTHST2
CTHST2
CTHST2 |
| | | ₩ Oo loop com | nter | /PRITVA/(# | PRITVA H | I |
| UMP | | i Data flag O | = orbiter 1= booster | /JUMPY /(1 | FRENCH O
PRINTW I
PRITVA I
PRWTSM M
WTSCH I
WTVOL M | JUMP
JUMP
JUMP
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JUMP
JUMP |
| CREW | | 1 Mumber of c | rem members | /CINPUT/(375 | PRITVA I
STORE M
WTSCH I | NCREW
NCREW
NCREW |
| ENGS | | I Total numbe | r engines per stage | /CINPUT/(376 | PRITVA I
STORE M
WTSCH I | NENGS
NENGS
NENGS |
| HOFU | | I Fuel densit | , | /CINPUT/(382 | PRITVA I
STORE M
WTSCH I | RHOFU
RHOFU
RHOFU |
| MOF U2 | | I Secondary f | uel desnity | /CINPUT/(383 | PRITVA I
STORE M | RHOFUZ
RHOFUZ
RHOFUZ |

| DRIRAN | MATH
Symbol | CODE | DESCRIPTION | STORA
BLOCK | GE
LOC | SUBROUTINE
SUBR CODE | USAGE |
|-------------|----------------|-----------------|--|-----------------|-----------|---|---|
| SYMBOL | STABUL | | | | | 0000 | |
| R HO K | | I Oxidi | zer density | /CIMPUT/(| 384) | STORE A F | X OH X |
| RH0 X 2 | | ' I Secon | dary oxidizer density | /CINPUT/(| 385) | STORE M F | HO X 2
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ut 4. Initial orbiter 5. Initial entry
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30003 FDRMAT(1H ,42HMACH NUMBER AT MAX 9
30004 FDRMAT(1H ,42HRELATIVE VELOCITY AT MAX 9
14H FPS)
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                           30005 FORMAT(1H , 42HRELATIVE FLIGHT PATH ANGLE AT MAX D
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Symbol | MATH
SYMBOL | CODE | DESCRIPTION | STORAG
BLOCK | LOC | SUBBOUT
Subb c | INE USAGE
ODE VAR |
|------------------|----------------|------|---|-----------------|------|--|---------------------------|
| 8800Y | | 1 | Body width used by set0 to set common to zero | /VOLCAL/(| 1) | | 1 8800Y
0 0
m 8800Y |
| CROOT | | ī | Ing root chord | /VOLCAL/(| 2) | PROTHR | |
| CSPAN | | 1 | Structural span along 0.5 chord | /VOLCAL/(| 3) | PROTHR
WTSCH | I CSPAN
M CSPAN |
| HBODY | | 1 | Body height | /VOLCAL/(| 7) | PROTHR
WTSCH | |
| KBBODY | | ₩ | Same as bbody in mks units | /PROTHR/(+ |) | PROTHR | W K88001 |
| KCROOT | | 닖 | Same as croot in mks units | /PROTHR/(+ |) | PROTHR | M KCROO |
| KCSPAN | | w | Same as espan in mks units | /PROTHR/(+ |) | PROTHR | W KCSPA |
| KHBODY | | W | Same as hbody in mks units | /PROTHR/(+ |) | PROTHR | W KHB001 |
| KILO | | ᄖ | Pounds to kilogram conversion | /PROTHR/(+ |) | PROTHR | M KILO |
| KLBODY | | 녆 | Same as Ibody in mks units | /PROTHR/(* |) | PROTHR | W KLBODY |
| KLROOT | | 0 | Same as croot in wks units | /PROTHR/(* |) | PROTHR |) KLR001 |
| KSBODY | | W | Same as shody in mks units | /PROTHR/(* |) | PROTHR | M KSBODY |
| KSHORZ | | W | Same as shorz in mks units | /PROTHR/(+ |) | PROTHR | N KSHORZ |
| KSPLAN | | W | Same as splan in mks units | /PROTHR/(+ |) | PROTHR (| d KSPLAN |
| KSVERT | | w | Same as svert in mks units | /PROTHR/(+ |) | PROTHR | # KSVERT |
| KSWING | | Ħ | Same as swing in mks units | /PROTHA/(+ |) | PROTHR | N K2PINE |
| KS XPOS | | W | Same as sxpos in mks units | /PROTHR/(+ |) | PROTHR | M KSXPOS |
| KUMBOD | | W | Same as umbody in mks units | /PROTHR/(+ |) | PROTHR I | |
| KUWHOR | | u | Same as umhorz in mks units | /PROTHR/(+ |) | PROTHR | |
| KUWVER | | u | Same as unvert in mks units | /PROTHR/(+ | | PROTHR | |
| KUWWIN | | w | Same as umming in mks units | /PROTHR/(+ | | PROTHR | |
| KWOVER | | W | Same as movers in mks units | /PROTHR/(* | | PROTHR | |
| LBODY | • | 1 | Body length | /VOLCAL/(| 8) | PROTHR :
Tamper :
WTSCH : | |
| PROTHR | | ε | Subroutine to print misc data | /PROTHR/(\$ |) | PRINTY S | |
| SBODY | | .1 | Total body metted area | /CINPUT/(| 386) | PROTHR :
Tamper
WTSCH : | SBODY |
| SFUTK | | I | Total fuel tank metted arem | /VOLCAL/(| 11) | PROTHR : | |
| SFUTKK | | 녀 | Same as sfutk in mks units | /PROTHR/(+ |) | PROTHR I | N SFUTKK |
| SHORZ | | I | Horizontal stabilizer planform area | /VOLCAL/(| 12) | PROTHR ! | 1 SHORZ |
| SOXTK | | 1 | Total oxidizer tank metted area | /VOLCAL/(| | PROTHR : | 4 SOXTK |
| SOXTKK | | ¥ | Same as soxtk in mks units | /PROTHR/(+ |) | PROTHR (| SOXTKK |
| SPLAN | | I | Body planform area | /VOLCAL/(| 14) | PROTHR I
TAMPER I
WTSCH (
WTVOL) | SPLAN
SPLAN |
| VERT | | 1 | Vertical fin planform area | /VOLCAL/(| 16) | PROTHR 1 | |
| MING | | ī | Gross wing area | /VOLCAL/(| 17) | PROTHR I | SWING |
| SXPDS | | 1 | Exposed ruling rarear | /AOFCVF/(| 18) | PROTHR 1 | SXPOS |

| ORTRAN | MATH | CODE | DESCRIPTION | STORAGE | SUBROUTINE USAG |
|---------|---------|--------------|------------------------|-------------|--|
| ZAMBOL | 2 AWBOT | | BESCHIT TION | BLÚCK L(| OC SUBH CODE VAR |
| TOVERC | | 1 Wing thick | ness over choord ratio | /CINPUT/(3 | 88) PROTHR 1 TOVER
STORE M TOVER
WISCH I TOVER |
| UWBODY | | ₩ Body unit | welght | /PROTHR/(+ |) PROTHR W UWBOD |
| UWHORZ | | ₩ Horizontal | tail unit weight | /PROTHR/(+ |) PROTHR W UWHOR |
| UWVERT | | W Vertical t | all unit meight | /PROTHR/(+ |) PROTHR W UWVER |
| UWWING | | W Wing unit | weight | /PROTHR/(+ |) PROTHR W UWWIN |
| WBASIC | | 1 Total weig | ht of basic body | /WTCALC/(| PROTHR I WBASI
PROTHR I WBASI
WTSCH M WBASI |
| WHORZ | | I Horizontal | stabilizer mt | /WTCALC/(| 55) PRINTW I WHORZ
PROTHR I WHORZ
WTSCH M WHORZ |
| WINFUT | | I Weight of | intergral fuel tank | /WTCALC/(| 57) PRINTW I WINFU
PROTHR I WINFU
WTSCH M WINFU |
| WINOXT | | I Weight of | integral oxidizer tank | /WTCALC/(| 58) PRINTW I WINOX
PROTHR I WINOX
WTSCH M WINOX |
| WOVERS | | I Wing loadi | ng | /WTCALC/(| 77) PROTHR I WOVER:
TAMPER I WOVER:
WTSCH M WOVER: |
| WSECST | | I Secondary | body structure #t | /WTCALC/(1 | 12) PRINTW I WSECS
PROTHR I WSECS
WTSCH M WSECS |
| WVERT | | I Vertical f | in meight | /WTCALC/(1 | 21) PRINTW I WVERT
PROTHR I WVERT
WTSCH M WVERT |
| WW I NG | | I Total stru | ctural mt. Of ming | /WTCALC/(1 | 33) PRINTW I WWING
PROTHR I WWING
WISCH M WWING |



| UHTRAN | MATH | CODE | DESCRIPTION | STORAGE | SUBROUTINE | USA |
|-----------|--------|-----------|-------------------|--------------|---|-----|
| SYMBOL | SYMBOL | | DE JOHII I I I IV | BLUCK LOC | SUBH CODE | VA |
| . UNO 6 . | | O File of | all output data | /.UN06./(\$) | BNORYC O CREAT O OFFICE O OOFFICE O OFFICE O OOFFICE O | |
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                                                                                                   REAL KILO, KSBODY, KSWING, KWDVER, KSVERT, KSHORZ, KUWWIN,

1 KUWVER, KUWHOR, KUWBOD, KLROOT, KLBODY, KBBODY, KHBODY,

2 KSXPOS, KSPLAN
REAL KCSPAN, KCROOT
REAL KIN
REAL ISP, K.LF, MR, NCREW, LBODY, NPASS
REAL NENGS
COMMON/CINPUT/
1ANENGS, ANTANK, ASRATO, ASWEEP, C(300), CBBODY, CFUEL
2 CHBODY, CSBODY, CSFAIR, CSFUIK, CSHORZ, CSDUT
41SP(6), 11PS, K(30), KIN
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WRITE(6,620) SFUTK, SFUTKK

WRITE(6,625) SOXTK, SOXTKK

650 WRITE(6,700)

WRITE(6,3000) SXPOS, KSXPOS

WRITE(6,3000) SXPOS, KSXPOS

WRITE(6,1000) SVERT

1050 WRITE(6,1000) SVERT

1050 WRITE(6,1100) SMDRZ

1250 WRITE(6,1100) SMDRZ

1250 WRITE(6,1100) UMWIND, KUMWIN

1450 WRITE(6,1500) UMVERT, KUMWIN

1450 WRITE(6,1600) UMVERT, KUMWIN

1650 IF(WINFUT. EQ.O. AND. WINDXT. EQ.O.) WRITE (6,1700) UMBDDY, KUMBDD

850 WRITE(6,1000) UMVERS

850 WRITE(6,2000)

WRITE(6,2000)

WRITE(6,2000)

WRITE(6,2000) CSPAN, KCSPAN

WRITE(6,2000) CSPAN, KCSPAN

WRITE(6,2000) CSPAN, KCSPAN

WRITE(6,2000) BODY, KBBDDY

WRITE(6,2000) BODY, KBBDDY

WRITE(6,2000) BODY, KBBDDY

WRITE(6,2000) BODY, KBBDDY

RETURN

40 FORMAT (/// 15X11MDESIGN DATA )

100 FORMAT(1H0,12HWETTED AREAS 29X,10H SQ. FT. ,10H SQ.M.

**)

200 FORMAT(1H0,40H GROSS BDDY (SBDDY)

PORMAT(1H0,40H GROSS BDDY (SBDDY)

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                                                          40 FORMAT (/// 15X11HDESIGN DATA )
100 FORMAT (1H0,12HWETTED AREAS 29X,10H SQ. FT.,10H SQ.M. PROTHR
200 FORMAT (1H0,40H GROSS BODY (SBODY)
620 FORMAT (1H1,18HFUEL TANKS (SFUTK), 22X, 2F10.2)
625 FORMAT (1H1,22HOXIDIZER TANKS (SFUTK), 18X, 2F10.2)
700 FORMAT (1H1,12HPLAN AREAS 29X,10H SQ. FT.,10H SQ.M. )
999 FORMAT (1H1,40H AND AREAS 29X,10H SQ. FT.,10H SQ.M. )
910 FORMAT (1H1,40H WING LOADING 2F10.2) PROTHR
1500 FORMAT (1H1,40H WING LOADING 2F10.2) PROTHR
1500 FORMAT (1H1,40H WERTICAL SURFACES (SHORZ) 2F10.2) PROTHR
1300 FORMAT (1H0,12HUNIT WEIGHTS 28X,10H LB/SQ.FT. ,10H KG/SQ.M. )
1400 FORMAT (1H1,40H WING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 10H BING 
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SUBROUT INE PRWTSM



| FURTHAN | MATH | COD | DESCRIPTION | STORAS | | SUAROUTIN | |
|----------|--------|----------|---|---------------|------|--|--|
| SYMBOL | SYMBOL | | <u> </u> | BLUCK | LOC | SUBA COU | E VAR |
| CFUEL | | M | Mixture retio | /CINPUT/(| 306) | PRWTSM M
Store M
Wtsch M | CFUEL
CFUEL
CFUEL |
| ı | | W | Do loop counter | /PRWTSM/(+ |) | PRWTSM W | 1 |
| 1 S P | | • 1 | Specific Impulse | /CINPUT/(| 330) | PRWTSM I
STORE M
WTSCH I
WTVOL D | 15P
15P
15P
15P |
| j | | ш | Do loop counter | /PRWTSM/(+ |) | PRWTSM W | J |
| J UMP | | M | Data flag 0= orbiter 1= booster |)\ Y9MUL\ | 1) | FRENCH D
PRINTW I
PRITVA I
PRWTSM M
WTSCH I
WTVOL M | AMD CAMP
AMD CAMP
AMD CAMP
AMD CAMP |
| CDELTV | | W | Velocity per arc (meters/sec) | /PRWTSM/(+ |) | PRWTSM W | KDEL1 |
| CI | | W | Constant = 6.0 | /PRWTSM/(+ |) | PRWTSM W | KI |
| KILO | | W | Pounds to kilogram conversion | /PRWTSM/(+ |) | PRWTSM W | KILD |
| KWABFU | | W | Same as wabfu in mks units | /PRWTSM/(* |) | PRWTSM W | KWABI |
| (WFUEL | | W | Same as wfuel(i) in mks units | /PRWTSM/(+ |) | PRWTSM W | KWFU |
| (WGROS | | W | Gross weight (killograms) | /PRWTSM/(+ |) | PRWTSM W | KWGRO |
| TBLW | | iii | Same as mjet(i) in mks units | /PRWTSM/(+ |) | PRWTSM W | KWJE1 |
| MO X | | ju) | Same as mox(i) in mks units | /PRWTSM/(# |) | PRWTSM W | KMOX |
| WPRIG | | W | Pre-ignition loss (kg) | /PRWTSM/(+ |) | PRWTSM W | KWPR |
| CWWAIT | | W | Same as mmait(i) in mks units | /PRWTSM/(* |) | PRWTSM W | KMM4) |
| 1R | | I | Mass ratio | /CINPUT/(| 369) | PRWTSM I
SOLVE I
STORE M
WTSCH M | MR
MR
MR
MR |
|)F | | W | Oxidizer to fuel mixture ratio 1. Thrust build-up 2. Not used 3. Main impulse 4. Main impulse reserve 5. Secondary impulse 6. Not used | /PRWTS#/(+ |) | PRWTSM W | 0F |
| PRWTSM | | E | Subroutine to print summary data | /PRWTSM/(\$ |) | PRWTSM E
WTVOL S | PRWTS |
| JABF U | | M | Weight of jpfuel | /WTCALC/(| 3) | PRINTW I
PRWTSM M
TAMPER I
WTSCH M | WABFL
Wabfl
Wabfl
Wabfl |
| TIAL | | W | Landing meight (lb) | /PRWTSM/(+ |) | PRWTSM W | MAIT |
| IAIT2 | | Ĺ | Landing weight (kg) | /PRWTSM/(+ |) | PRWTSM W | WAIT |
| IENTRY | | D | Entry weight | /EMS /(| 3) | PRWTSM D
Tamper I | WENTE |
| JETURN | | 0 | Weight at return point | /EMS /(| 2) | PRWTSM O
Tamper I | WETUR |
| IFUEL | | M | Fuel weight 1. Thrust build-up fuel 2. Not used 3. Main impulse fuel wt. 4. Main impulse fuel reserve 5. Secondary impulse fuel 6. Not used | /WTCALC/(| 37) | PRWTSM M
WTSCH M | WFUE |
| GROSS | | 1 | Gross lift-off welght | /CINPUT/(| 392) | STORE M
TAMPER I | WGRO!
WGRO!
WGRO!
WGRO!
WGRO!
WGRO! |
| NJET
 | | M | Jettison weight 1. Ignition to lift-off 2. Not used 3. Jettison during ascent 4. In-orbit jettison wt. 5.7 Pre-entry jettison wt 6Fly back-jettison wt. | /WTCALC/(
 | | PRITVA I
PRWISM M
STORE O
TAMPER I | MJET
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WJET |

| SYMBOL | MATH
Symbol | CODE | DESCRIPT | TION | STORAG
BLULK | E
LOC | SUBB CODE | E VAR |
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| MLAND | | 0 Landi | ng melght | | /EMS /(| 4 } | PRWISM O
TAMPER I | WLAND
WLAND |
| WLOSS | | [In-fi | ight meight loss | | /WTCALC/(| 70) | PRINTW I
PRWTSM I
WTSCH O | WLOSS
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WLOSS |
| WORBIT | | 0 Weight | t in orbit | | /EMS /(| 1) | PRWTSM O
TAMPER I | WORBIT
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| wo x | | oxidi:
Main i | t build-up oxidizer 1. T
zer 2. Not used 3. Main
impulse oxidizer reserve
zer 6. Not used | impulse oxidizer 4. | /WTCALC/(| 78) | PRWTSM M
WTSCH M | 주 의 X
주의 X |
| WPREIG | | M Pre-ig | gnition losses | | /WTCALC/(| 105) | PRINTE I
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| WWAIT | | Burnoi | ry meights 1. Ignition 2
ut 4. Initial orbiter 5.
al flyback 7. Landing | . Take-off 3.
Initial entry 6. | /WTCALC/(| 122) | PRITVA I
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PRWTSM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PRWITSM
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72.
73.
74.
75.
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PRUTSM
PRUTSM
PRUTSM
4
                                                                                                                                                                                                                                      10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         25
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1 79:
                                                  20 CONTINUE
60 TO 50
                                                                                                                                                                                                                                                                                                                                                                                                        PRUTSM
                                                                                                                                                                                                                                                                                                                                                                                                         PRWTSA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  50
                                                              CONTINUE
WRITE (6,664)
WRITE (6,665)
WRITE (6,666)(I,MR(I),OF(I),ISP(I),DELTAV(I),KDELTV(I), I=1,6)
        78.
79.
80.
                                                                                                                                                                                                                                                                                                                                                                                                        PRWTSM
PRWTSM
PRWTSM
          81.
                                         WAITE (6,666)(I,MH(I),UFLI,135.

50 WRITE(6,100)
WRITE(6,240)
150 WRITE(6,200) WGRDSS,KWGROS
WRITE(6,207) WWAIT(1),KWFUEL(1)
WRITE(6,207) WWAIT(1),KWFUEL(1)
WRITE(6,201) WFUEL(1),KWFUEL(1)
WRITE(6,201) WJET(1),KWJET(1)
WRITE(6,300) WJET(1),KWJET(1)
WRITE(6,300) WJET(1),KWJET(1)
WRITE(6,300) WWAIT(2),KWWAIT(2)
WENTRY = WWAIT(6)
JUMP = JUMP + 1
GO TO (260,260), JUMP

240 WRITE (6,210) WFUEL(3), KWFUEL(3
          82.
83.
84.
85.
                                                                                                                                                                                                                                                                                                                                                                                                         PRHTSM
                                                                                                                                                                                                                                                                                                                                                                                                       PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
          86.
          87.
88.
89.
90.
91.
92.
                                  160
                                                                                                                                                                                                                                                                                                                                                                                                       PRHISM
PRHISM
PRHISM 260-280-
                                          GO TO (260,280), JUMP

260 WRITE (6,210) WFUEL(3), KWFUEL(3)
WRITE (6,220) WOX(3), KWDX(3)
WRITE (6,230) WJET(3), KWJET(3)
WRITE (6,401) WWAIT(4), KWWAIT(4)
WRITE (6,401) WWAIT(4), KWJET(4)
WRITE (6,230) WJET(4), KWJET(4)
WRITE (6,230) WJET(4), KWJET(4)
WRITE (6,20) WWAIT(5), KWGUEL(5)
WRITE (6,20) WOX(5), KWGX(5)
WRITE (6,230) WJET(5), KWJET(5)
WRITE (6,230) WJET(5), KWJET(5)
WRITE (6,230) WJET(5), KWJET(5)
JUMP = JUMP - 1
JUMP - 10 TO TO TO
280 WRITE (6,210) WFUEL(3)
                                                                                                                                                                                                                                                                                                                                                                                                       PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
      94.
95.
96.
97.
98.
99.
100.
                                                                                                                                                                                                                                                                                                                                                                                                       PRUTSM
PRUTSM
PRUTSM
       104.
105.
                                                                                                                                                                                                                                                                                                                                                                                                       PRWTSM
PRWTSM
PRWTSM
    106.
107.
                                                                                                                                                                                                                                                                                                                                                                                                                                            765-
                                         1PLJUMP.EQ 0 ) 60 TO 765

280 WRITE (6,210) WFUEL(3), KWFUEL(3)
WRITE (6,220) WDX(3), KWDX(3)
WRITE (6,1000) WMAIT(4), KWMAIT(4)
WETURN = WMAIT(4)
WRITE (6,1005) WJET(4), KWJET(4)
WRITE (6,500) WWAIT(5), KWJET(5)
WRITE (6,1015) WJET(5), KWJET(5)
WRITE (6,1015) WMAIT(6), KWWAIT(6)
JUMP=JUMP-1

765 WMAREU = MAREU = MAREU
                                                                                                                                                                                                                                                                                                                                                                                                      PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
PRUTSM
    108.
      114.
115.
                                            765 KWABFU = WABFU + KILO
                                         765 KWABFU = WABFU * KILO

WABFU = - WABFU

KWABFU = - KWABFU

WRITE (6,225) WABFU, KWABFU

WAIT = WMAIT(7)

WLAND = WAIT

WABFU = - WABFU

WAIT2 = KWWAIT(7)

WRITE (6,600) WAIT,

WRITE (6,600) WAIT,

OD 120 1=1, KI

IF(WPREIS.NE.O.) WPREIG=-WPREIG

DO 120 1=1, KI

IF(WJET(1).NE.O.) WJET(1)=-WJET(1)

IF(WJET(1).NE.O.) WJET(1)=-WFUEL(1)

1F(WOX(1).NE.O.) WOX(1)=-MOX(1)

120 CONTINUE

IF(WJET(6).EQ.WLOSS) WJET(6) = 0.
                                                                                                                                                                                                                                                                                                                                                                                                       PRWTSM
PRWTSM
PRWTSM
PRWTSM
    118.
   119.
120.
121.
122.
                                                                                                                                                                                                                                                                                                                                                                                                       PRWTSM
PRWTSM
PRWTSM
PRWTSM
  122.
123.
124.
125.
126.
127.
128.
129.
                                                                                                                                                                                                                                                                                                                                                                                                       PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
PRWTSM
 130.

131.

132.

133.

134.

135.

136.

137.

138.

137.

140.

141.

142.

143.

145.

146.

147.

148.
                               PRUTSM
2F10.0) PRUTSM
2F10.0) PRUTSM
2F10.0) PRUTSM
2F10.0) PRUTSM
2F10.0) PRUTSM
2F10.0) PRUTSM
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2F10.0) PRUTSM
2F10.0) PRUTSM
2F10.0) PRUTSM
                                                                                                                                                                                                                                                                                                                                                      2F10.0)
                                                                                                                                                                                                                                                                                                                                                       2F10.0) PRWTSM
PRWTSM
2F10.0) PRWTSM
                                                                                                                                                                                                                                                                                                                                                 2F10.0)
2F10.0)
```

```
567 FORMAT(1HO, 40HENTRY WEIGHT (WENTRY)
664 FORMAT (1HI)
665 FORMAT(69X, 31HTHEORETICAL VELOCITY INCREMENT / 51X

* 14HO/F RATIO 15P, 5X, 28H FEET/SECOND METERS/SECOND
666 FORMAT(1HO, 11H MASS RATIO, 20X, 12, 1H=, F10.4,

* F12.4, 3KF6.1, 2KF10.1, 5KF10.1)
800 FORMAT(1HO, 40HIANDING WEIGHT (WLAND)
1000 FORMAT (1HO, 40HINITIAL SEPARATION
1005 FORMAT (1H, 40H THRUST DECAY AND RESIDUALS
1010 FORMAT (1H, 40H JETTISON AND EXPENDABLES
1015 FORMAT (1H, 40H THRUST DECAY AND RESIDUALS
1015 FORMAT (1HO, 40HINITIAL FLYBACK
END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          2F10.0) PRMTSM PRMTSM PRMTSM PRMTSM CKOUT PRMTSM 10.0) PRMTSM 10.0) PRMTSM PRMTSM PRMTSM PRMTSM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        2F10.0 )
2F10.0)
2F10.0)
2F10.0)
2F10.0)
```

*

SUBRØUT I NE RANGE

| ORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAGE
BLOCK | LOC | | | E VAR |
|------------------|----------------|--------------------------------|---|---------------------|-----|--|--------------------------------------|---|
| | | | | | | | | |
| GAMS | | W Flyback fli | ght path angle | /RANGE /(+ |) | RANGE | W | SAMS |
| HA | | W Apogee miti | tude | /RANGE /(+ |) | RANGE | | HA |
| HAA | | I Apogee alti | tude | /RANGE /(+ |) | RANGE | I | HAA |
| HAATBL | | C Table value | of apogee alt | /RANGE /(+ |) | RANGE | С | HAATE |
| 1 5 MD | | W Integer val | ue of flybck | /RANGE /(+ | , | RANGE | ¥ | 1540 |
| PSI | | W Initial pit | ch attitude for range calculations | /RANGE /(+ |) | RANGE | u | PSI |
| PSITBL | | C Table value calculation: | of pitch attitude for range
s | /RANGE /(+ | , | RANGE | C | PSITE |
| 1 | | W Range | | /RANGE /(+ |) | RANGE | Ħ | R |
| RANGE | | E Subroutine on flybck | to evaluate booster flyback range based | /RANGE /(\$ | , | ITER8
Range | S
E | RAMGE
RAMGE |
| | | flyback dati | data array (37,5) that contains the a and some injection quantities | /S1Z1NG/(| | REU3 SIZE SIZEMR SIZIN STAU STAU SUMOUT TAMPAR TAMPER THRUST TRTOSZ VEHDF MT VOL | MITITOORNIROPRESE | 50
50
50
50
50
50
50
50
50
50
50
50
50
5 |
| | | | array (28) containing staging and misc flags | /\$121 W G/(| 46) | ENVPRM
FLYBKP
ITERS
RAIZEM
SIZEM
SIZEM
SIZEM
TAMPAR
TAMPAR
TAMPER
VEHDF
WIVOL | I
I
I
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I
I
O
M | 25252525252525252525252525252525252525 |
| BLZD | | S Two dimension | nai table look-up surboutine | /TBL2D /(\$ |) | RANGE
TBL2D | S
E | TBL2D
TBL2D |
| ' A | | W Apogee veloc
determinatio | ity parameter used in flyback range
m | /RANGE /(+ |) | RANSE | ¥ | VA |
| AA | | l Velocity par calculations | ameter used in flyback range | /RANGE /(+ |) | RANGE | i | VAA |
| AATBL | | C Staging velo | city in range tables | /RANGE /(# |) | RANGE | С | VAATBI |
| S | | W Staging velo | city | /RANGE /(+ |) | RANGE | W | ٧S |
| STBL | | C Table value | of staging velocity | /RANGE /(+ |) | RANGE | ε | VSTBL |

| BN
CR
FX
GE
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| PR PR . S SD SI SI SI SI SI SI SI SI SI SI SI SI SI | AYOZ O RINTY O RINTY O RINTY O RINTY O RINTWO RITYA O ROTHR O ROTHR O ROTHR O ROTHR O ROTHR O LIZE O LIZIN O LIZE O LIZIN O LIZE O LIZIN O LIZE O LIZIN O LIZE O LIZOUT O LIZE O LIZOUT | - UNO (-)))))))))))))))))))))))))))))) |

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1.
2.
3.
4.
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
                                 SUBROUTINE RANGE
SUBROUTINE TO CALCULATE FLYBACK RANGE
               CCC
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
RANGE
                              DIMENSION VSTBL(7), HSTBL(5), HANTBL(7,5), HAATBL(7,5), 2 VAATBL(7,5), VAATBL(7,5), RABTBL(7,5), RABTBL(7,5), VARTBL(7), PSTBL(7), PSTBL(7), HRATBL(7,4), HRBTBL(7), PSTBL(4), HRATBL(7,4), HRBTBL(7,4)
    6.
                                                                                                                                                                                                                                        RANGE
RANGE
SIZING
    8.
9. C
                             16.
 11.
                                                                                                                                                 PZ(5),
TLNG,
                                                                                                                                                                                                                SW(20), SIZING
SIZING
                                                                                                                                                                                                                SIZING
THRATZ, SIZING
THRATZ, SIZING
IPSMAX, SIZING
ISPB, SIZING
SIZING
SIZING
SIZING
UM
RANGE
BANGE
             C
                                                                                                                                                 TOLWT,
1SIZE,
PRFLG,
1DVEL,
WEB,
VSTG,
ITNBW
                                                                                                                                                                                 WPB
TRAFLG,
IPASS,
ISPO,
WO,
19.
20.
21.
ITNOW
                                                                                                                                            ,1520(14)
                                          PARAMETRIC RANGE DATA BASED ON
W/CL+S = 80.7 PSF
L/D - MAX AT CL-MAX=0.5
CL-MAX = 0.723 AT ALPHA = 60 DEG
TERMINAL ALTITUDE = 50,000 FT
180-DEGREE MANEUVER
MAXIMUM LOAD FACTOR = 46
DATA LIMITS
APOGEE ALTITUDE = 300,000 FT
APOGEE VELOCITY = 13,000 FPS
PATH ANGLE = 14 DEGREES
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
                                                                                                                                                                                                                                        RANGE
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
RANGE
                                                                                                                                                                                                                                        RANGE
                                                                                                                                                                                                                                        RANGE
                               DATA HSTBL/ 150000., 175000., 200000., 225000., 250000./
                                                                                                                                                                                                                                        RANGE
                                DATA VSTBL/ 7000., 8000., 9000., 10000., 11000., 12000., 13000./
                                                                                                                                                                                                                                        RANGE
            C
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
4123.4456749
                             DATA HANTBL/ 2.175, 2.240, 2.320, 2.410, 2.505, 2.6075, 2.7125, 2.2115, 2.145, 2.190, 2.250, 2.325, 2.405, 2.485, 3.2.055, 2.073, 2.100, 2.125, 2.160, 2.200, 2.240, 4.2.035, 2.038, 2.042, 2.050, 2.060, 2.080, 2.105, 5.0105, 2.020, 2.022, 2.025, 2.030, 2.032, 2.035/
                                                                                                                                                                                                                                        RANGE
                                                                                                                                                                                                                                        RANGE
            C
                                                                                                                                                                                                                                        RANGE
                              DATA HAATBL/ 195., 200., 200., 197., 193., 187., 175., 2 150., 183., 203., 215., 220., 220., 220., 3 200., 250., 303., 353., 405., 460., 510., 4 220., 290., 375., 470., 570., 670., 780., 5 235., 320., 415., 520., 640., 790., 880./
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
RANGE
                                                                                                                                                                                                                                        RANGE
            C
                             DATA VAATBL/ 3.65, 6.00, 8.25, 10.60, 12.90, 15.40, 18.25, 2 1.70, 2.30, 3.20, 4.40, 5.90, 7.55, 9.30, 3 0.70, 1.15, 1.60, 2.35, 3.25, 4.45, 6.00, 4.1.00, -1.40, -1.00, 0.02, 1.70, 2.70, 2.70, 5 -1.30, -1.80, -1.70, -1.25, -0.70, -0.45, -0.70/
                                                                                                                                                                                                                                        RANGE
                                                                                                                                                                                                                                        RANGE
RANGE
                                                                                                                                                                                                                                        RANGE
                                                                                                                                                                                                                                        RANCE
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
            С
                             DATA VABTBL/ -122.0, -166.0, -212.0, -260.0, -309.0, -360.0, -416.0, 2-62.0, -70.0, -103.0, -133.0, -167.0, -202.0, -240.0, 3 -38.0, -47.0, -58.0, -73.0, -92.5, -119.0, -153.0, 4 -6.0, -10.0, -15.0, -22.0, -32.0, -46.0, -67.0, 5 5.0, 2.5, 0., -2.5, -6.0, -12.5, -22.5/
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
RANGE
            С
                             DATA RAATBL/ 0.05, 0.065, 0.10, 0.18, 0.33, 0.385, 0.40, 2 0.02, 0.08, 0.16, 0.26, 0.39, 0.54, 0.73, 0.70, 0.07, 0.07, 0.11, 0.15, 0.25, 0.52, 4 -0.05, 0.01, 0.04, 0.055, 0.66, 0.698, 0.201, 0.04, 0.03, 0.01, -0.018, -0.04, -0.05, 0.03/
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
                                                                                                                                                                                                                                        RANGE
RANGE
RANGE
RANGE
68.
69.
70.
71.
72.
73.
74.
75.
            C
                             DATA RABIBL/ 2.3, 2.8, 3.1, 2.8, 2.2, 2.5, 3.4, 2 3.7, 4.1, 4.2, 4.9, 5.2, 5.55, 5.8, 3.4, 3.45, 4.85, 6.45, 8.3, 9.8, 16.9, 11.6, 4.5, 16.8, 5.2, 5.2, 6.3, 9.0, 11.8, 14.25, 16.8, 5.4.1, 5.9, 8.0, 10.5, 13.2, 16.1, 19.4/
                                                                                                                                                                                                                                        RANGE
                                                                                                                                                                                                                                        RANGE
```

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めノニノ
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```
16. C
17.
18. C
19.
                                   DATA VATBL/ 7000., 8000., 9000., 10000., 11000., 12000., 13000./ RANGE RANGE DATA HATBL/ 180000., 200000., 220000., 240000., 260000., 280000., RANGE
                                                                                                                                                                                                                                    RANGE
RANGE
RANGE
    80.
    81.
82.
83.
                                DATA PSATBL/ 90.0, 90.0, 89.0, 85.0, 83.0, 81.0, 79.5, 287.0, 80.5, 76.0, 73.5, 72.0, 71.0, 71.0, 381.5, 66.5, 63.0, 62.0, 61.5, 61.5, 62.0, 46.5.0, 58.5, 55.5, 54.0, 54.5, 56.0, 58.5, 58.5, 55.0, 32.5, 32.0, 33.0, 35.0, 38.0, 41.5, 617.0, 16.0, 17.0, 19.0, 22.0, 25.5, 30.0, 70.0, 0.0, 1.5, 4.0, 8.0, 13.0, 19.0/
                                                                                                                                                                                                                                    RANGE
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
RANGE
    88.
89. C
                                   DATA PSITBL/ 0., 45., 60., 75./
                                                                                                                                                                                                                                    RANGE
RANGE
RANGE
               ε
                                DATA HARTBL/150000., 175000., 200000., 225000., 1 250000., 275000., 300000./
   93.
94. E
95.
96
97.
98.
                                DATA HRATBL/ 7*16.0E-07, 1.915E-07, 7.955E-07, 1.7985E-07, 7.950E-07, 1.915E-07, 7.955E-07, 1.7994E-07, 8.000E-07, 8.040E-07, 2.3204E-07, 4.100E-07, 4.636E-07, 3.900E-07, 2.5.176E-07, 3.550E-07, 5.591E-07, 2.600E-07, 3.131E-07, 3.550E-07, 3.958E-07/
                                                                                                                                                                                                                                    RANGE
                                                                                                                                                                                                                                   RANGE
                                                                                                                                                                                                                                    RANGE
                                                                                                                                                                                                                                    RANGE
                                                                                                                                                                                                                                    RANGE
   101.
                                                                                                                                                                                                                                    RANGE
                                DATA HRBTBL/ 0., 0.250E-02, 0.475E-02, 0.650E-02, A 0.800E-02, 0.950E-02, 1.100E-02, 1.057E-02, 0.650E-02, 1.057E-02, 0.600E-02, 0.992E-02, 1.150E-02, 1.127E-02, 1.275E-02, 1.425E-02, 1.502E-02, 1.552E-02, 1.652E-02, 1.275E-02, 3.0.931E-02, 1.120E-02, 1.275E-02, 1.400E-02, 1.502E-02, 1.726E-02, 1.502E-02, 1.630E-02, 1.726E-02, 1.400E-02, 3.1522E-02, 1.630E-02, 1.726E-02/
   102
               C
                                                                                                                                                                                                                                    RANGE
                                                                                                                                                                                                                                    RANGE
  104.
                                                                                                                                                                                                                                    RANGE
                                                                                                                                                                                                                                    RANGE
RANGE
RANGE
  108
                                                                                                                                                                                                                                    RANGE
 110.
111.
112.
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
              C
                                  BANK ANGLE DURING ENTRY = PSI = SQ(10,2) SQ(10,2) = 0.
 113.
114.
115.
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
                  000
                                             TEST FLYBACK OPTION FLAG
 116.
117.
                                                                                                                                                                                                                                   RANGE
                                   ISND = IFIX(5Q(19,5)+.1)
GO TO (100,200,300,400,500), ISMD
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
 118
                                                                                                                                                                                                                                                       100-7200-7300-7400-7500
120.

121. C

122.

123.

124. C

125.

126.

127.
                     100 CONTINUE

DETAILED FLYBACK RANGE CALCULATIONS
VS = SV(8)
HS = SV(9)
                                                                                                                                                                                                                                   RANGE
                                                                                                                                                                                                                                   RANGE
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
                                  MS = SW(9)

CHECK STAGING ALTITUDE

IF(MS.GT 250000.) WRITE(6,1000)

IF(MS GT.250000.) MS = 250000.

IF(SY(10) .LE. 0.) GAMS= 0.0001

GAMS = SV(10)

CHECK STAGING PATH ANGLE

IF(GAMS.GT.14.) WRITE(6,2000)

IF(GAMS.GT.14.) GAMS = 14.

DRS = SW(10)
                                                                                                                                                                                                                                   RANGE
                                                                                                                                                                                                                                   FINI
RANGE
RANGE
 128.
129. C
130.
131
132.
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
RANGE
 134.
135.
136.
137.
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
RANGE
                                               CALCULATE APOGEE ALTITUDE
                                   CALL TBL2D(VS, MS, VSTBL, HSTBL, HANTBL, HAN)
CALL TBL2D(VS, MS, VSTBL, HSTBL, HAATBL, HAA)
HA = HAA+GAMS++HAN + HS
  138.
139.
140.
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
                  C
C
C
                                              CALCULATE APOGEE VELOCITY
140.
141.
142
143
144.
145.
146.
147.
148.
149.
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
RANGE
                                   CALL TBL2D(VS, HS, VSTBL, HSTBL, VAATBL, VAA)
CALL TBL2D(VS, HS, VSTBL, HSTBL, VABTBL, VAB)
VA = VAA+GAMS++2. + VAB+GAMS + VS
                 000
                                                                                                                                                                                                                                   RANGE
RANGE
RANGE
                                               CALCULATE RANGE TO APOGEE
                                   CALL TBL2D(VS, HS, VSTBL, HSTBL, RAATBL, RAA)
CALL TBL2D(VS, HS, VSTBL, HSTBL, RABTBL, RAB)
RA = RAA+GAMS++2. + RAB+GAMS
```

```
RANGE
RANGE
RANGE
             CCC
                                TEST APOGEE ALTITUDE
152.
153.
154.
155.
156.
157.
158.
159.
160.
162.
163.
164.
165.
166.
                         IF(HA.GT.300000.) WRITE(6,3000) IF(HA.GT.300000.) HA = 300000.
                                                                                                                                                              RANGE
RANGE
RANGE
RANGE
             C
C
C
                                RETREIVE BANK ANGLE REQUIRED AND TEST
                                                                                                                                                              RANGE
RANGE
RANGE
                        CALL TBL2D(VA, HA, VATBL, HATBL, PSATBL, PSI)
IF(PSI.GE.75.0) PSI = 75.0
SQ(10,2) = PSI
                                                                                                                                                              RANGE
RANGE
RANGE
            CCC
                                 CALCULATE RANGE
                                                                                                                                                              RANCE
                        CALL TBL2D(HA,PSI,HARTBL,PSITBL,HRATBL,HRA)
CALL TBL2D(HA,PSI,HARTBL,PSITBL,HRBTBL,HRB)
RR = HRA+VA++2. + HRB+VA
                                                                                                                                                              RANGE
RANGE
RANGE
168.
169.
170.
            C
                        R = 60.+DRS + RA + RR + 50(10,3)
             00000000
                        SQ(10,3) IS A FLYBACK ADDITIVE RANGE FACTOR TO ACCOUNT FOR THE FINITE TIME REQUIRED TO ACCOMPLISH VARIOUS REENTRY MANEUVERS. DRNG IS THE NUMBBIC INPUT IN DATA2.
                                                                                                                                                              RANGE
                                                                                                                                                              RANGE
RANGE
RANGE
RANGE
                                IF VARABLE GEOMETRY CONFIGURATION GO TO 10
                                                                                                                                                              RANGE
RANGE
RANGE
RANGE
RANGE
RANGE
175.
176.
177.
178.
179.
180.
                        IF(SW(9).NE.1.) 60 TO 10
            C
                        SH(15) = R
            C
                        RETURN
             ç
183.
                        CORRECT FG RANGE PREDICTION FOR VG CONFIGURATION
                                                                                                                                                             RANGE
184.
185.
                  10 SW(15) = R+(0.7230/5W(9))++0.25
RETURN
                                                                                                                                                              RANGE
                                                                                                                                                              RANGE
             C
                                                                                                                                                              RANSE
187.
                200 CONTINUE
FLYBACK RANGE = FUNCTION OF STAGING @ ONLY
                                                                                                                                                              RANGE
            00000
                                                                                                                                                             RANGE
                                                                                                                                                             RANGE
RANGE
RANGE
189.
190.
191.
192.
193.
194.
195.
196.
197.
                        SPECIAL FLYBACK RANGE COMPUTATION FOR MSC VQ= LOG(10) Q STAGE
                                                                                                                                                             RANGE
CKOUT
RANGE
                        VO = ALOG10($V(12))
RNG = -55.915 + VO + 430.0
                                                                                                                                                              RANGE
             00000
                        SQ(10,3) IS A FLYBACK ADDITIVE RANGE FACTOR TO ACCOUNT FOR THE FINITE TIME REQUIRED TO ACCOMPLISH VARIOUS REENTRY MANEUVERS. DRNG IS THE MARMONIC INPUT IN DATA2. SW(15) = FLYBACK RANGE SM(15) = RNG + SQ(10,3)
                                                                                                                                                             RANGE
RANGE
RANGE
                                                                                                                                                              RANGE
200.
201.
202.
                                                                                                                                                              RANGE
RANGE
RANGE
             C
                                                                                                                                                              RANGE
203.
                        RETURM
                                                                                                                                                              RANGE
                300 CONTINUE

FLYBACK RANGE = CONSTANT = SQ(10,3) INPUT IN DATA2

SW(15) = SQ(10,3)

RETURN
205.
                                                                                                                                                              RANGE
205.
206.
207.
208.
209.
            C
                                                                                                                                                              RANGE
             C
                                                                                                                                                              RANGE
                400 CONTINUE
FLYBACK RANGE = IIP
SW(10) = CFNTRAL ANGLE FROM LIFT OFF TO STAGING
SQ(12,1) = IIP CENTRAL ANGLE FROM STAGING TO IMPACT = Z(89)
SQ(10,3) = ADDITIVE RANGE FACTOR (DATA2 INPUT)
SW(15) = 60.+(SQ(12,1) + SW(10)) + SQ(10,3)
210.
211.
                                                                                                                                                              RANGE
            0000
                                                                                                                                                             RANGE
RANGE
RANGE
RANGE
211.
212.
213.
214.
215.
216.
217.
                                                                                                                                                              RANGE
                                                                                                                                                              RANGE
218.
219.
220.
221.
                        .com·imul

-- Flyback trajectory to be Numerically integrated ****

RETURN
                500 CONTINUE
                                                                                                                                                             RANGE
                                                                                                                                                             RANGE
RANGE
RANGE
            ε
              1000 FORMAT(74H STAGING ALTITUDE GREATER THAN 250000 FT - FLYBACK RANGE RANGE RANGE RANGE RANGE
```

2000 FORMAT(68H STAGING GAMMA GREATER THAN 14 DEG - FLYBACK RANGE EÐUAT RANGE 110NS INVALID) 30GO FORMAT(73H APOGEE ALTITUDE GREATER THAN 3GOCGO FT - FLYBACK RANGE 1EÐUATIÐNS INVALID) END



SUBRØUT I NE SETO

| FURTRAN
Symbol | MATH
54MBOL | CODE | DESCRIPTION | STORA'
BLU! K | LOC | | INF USAGE
ODE VAR |
|-------------------|----------------|------|--|------------------|-----|------|---------------------------|
| A | | 0 | Number of air breathing engines used by set0 to set common to zero . | /CINPUT/(| 1) | | |
| C | | 0 | Airbreathing fuel system weight used by set0 to set common to zero | /WTCALC/(| 1) | | O C
M ABFSYS |
| D | | 0 | Body width used by set0 to set common to zero | /VOLCAL/(| 1) | | I BBODY
O D
M BBODY |
| I | | W | Do loop counter | /SETO /(4 | , , | SET0 | W I |

```
SUBRDUTINE SETO

C INITIALIZES VEHICLE DATA TO ZERO

COMMON/CINPUT/A(392)

COMMON/VOLCAL/D(37)

COMMON/WICALC/C(134)

DO 10 I=1,392

10 A(1)=0

DO 30 I=1,134

30 C(1)=0

DO 40 I=1,37

40 D(1)=0

RETURN
END
                                                                                                                                                                                                                                     000
```

SUBRØUTINE SIZEMR

| FORTRAN
Symbol | MATH
Symbol | CODE | · DESCRIPTION | BLOCK | GE
LOC | SUBROUTINE
SUBR CODE | |
|-------------------|----------------|-----------------|--|-----------|-----------|--|---|
| 3111000 | 3111000 | | | 0000 | | Jun cone | **** |
| SE . | | i Array | of synthesis iteration propulsion parameters | /SIZING/(| 259) | PRITVA I SIZEMR I SIZ | |
| SQ | | M Asyn
flyba | thesis data array (37,5) that contains the ck data and some injection quantities | /SIZING/(| 74) | FLYBKP M S
ISPRAT I S
POBC I S
PRITVA I S
RANGE M S
REU3 O S | 900000000000000000000000000000000000000 |
| SV | | | thesis array (28) containing staging eters and misc fings | /SIZING/(| 46) | ENVPRM M S FLYBKP I S ITERS I S SIZENR M S SIZENR M S SIZIN I S SUMDUT I S TAMPAR M S TAMPAR M S TRTOSZ M S WHTVOL I S | A A A A A A A A A A A A A A A A A A A |
| T B2 7 | | I Store | d booster value of isp(i) | /ORBINY/C | | SSSP I TO
STORE M TO
SUMOUT I TO
TAMPER I TO
VEHDE M TO | 827
827
827
827
827
827
827 |
| 1027 | | 1 Store | d orbiter value of Isp(I) | /ORBINX/(| | SSSP 1 TO
STORE M TO
SUMOUT 1 TO
VEHOF M TO | 027
027
027
027
027
027 |

8 NOV 72 6.01-46

```
SIZEMR
SIZEMR
SIZEMR
SIZEMR
SIZING
                            SUBROUTINE SIZEMR
CCC
                       SUBROUTINE TO EVALUATE MAIN IMPULSE MASS RATIOS
                                                                                                                                                                         SIZING
SIZING
SIZING
SW(20), SIZING
SIZING
             ε
                                                                                                                                                                          SIZING
SIZING
SIZING
THRATO, SIZING
IPSMAX, SIZING
ISPB, SIZING
SIZING
SIZING
             C
                                                                                                                                                                                             SIZING
                                                                                                                                                                                             UH
                                                                                                                                                                                              CKAUT
                                                                                                                                                                                             ORBINX
ORBINX
ORBINX
ORBINX
                                                                                                                                                                                             ORBINX
CKOUT
                                                                                                                                                                                             UH
UH
ORBINY
CKOUT
                       7 T077, T073, T074, T075, T076, T077, T078, T079, T080, 1081, 1062, 1063, 8T084
DIMEMSION SKB(30), SCB(300), TB4(6), TB20(10), TB27(6), TB34(6), 1 TB48(10), TB49(10), TB50(10), TB57(6), BMSAVE(10)
COMMON/CRBINY/
1 T81, TB2, TB3, TB4, TB5, TB6, TB7, T88, TB9, TB10, TB11, TB12, TB13, TB14, 2 TB13, TB14, TB17, TB18, TB15, TB20, TB21, IB22, IB23, IB24, IB25, IB26, IB27, 3 1822, IB29, IB30, IB31, IB32, TB33, TB34, TB35, TB36, IB37, TB38, TB39, TB40, 4 TB41, TB42, TB43, TB44, TB45, TB46, TB47, TB48, TB49, TB50, TE51, TB52, TB53, 5 TB54, TB55, TB56, TB57, T858, SCB, BMSAVE
6, TB59, TB60, TB61, TB62, TB63, TB64, TB65, TB66, TB67, TB68, TB69, TB70, TB71, TB72, TB73, TB74, TB75, TB76, TB77, TB78, TB79, TB80, TB81, TB82, 8TB83, TB84
                                                                                                                                                                                             ORBINY
ORBINY
ORBINY
                                                                                                                                                                                             ORBINY
UH
UH
SIZEMR
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SIZEMR
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SIZEMR
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SIZEMR
SIZEMR
SIZEMR
39.
41.
42.
45.
          C
C
                                     CALCULATE LAST STAGE MASS RATIO
                          SV(6) = SV(7)/SV(4)
            CCC
4449012345678901234567
                                    CALCULATE BOOSTER MASS RATIO
                          SV(28) = VV(1)/QP(9)
                                                                                                                                                                                             CKOUT
SIZEMR
SIZEMR
SIZEMR
SIZEMR
            CCC
                                    TEST PARALLEL BURN FLAG
                           1F( SE(2), NE.1.) GO TO 1
            5
C
C
                                                                                                                                                                                             SIZEMR
SIZEMR
SIZEMR
                                     CALCULATE EFFECTIVE FIRST STAGE MASS RATIO
                                                = 32.174 + T027(3) + ALOG(5V(6))
= EXP((5V(3)- ORBDV)/32.174/QP(13))
                                                                                                                                                                                             SIZEMR
SIZEMR
SIZEMR
SIZEMR
SIZEMR
SIZEMR
                           ARRDY
           000
                                    DETERMINE BOOSTER SIZING MASS RATIO
                           TBPAR = VV(1)/EFFMR *(EFFMR -1.)* QP(13) / QP(1)
TBPARO = TBPAR * T027(3)/ QP(2)
SV(28) = (VV(1) - WPPARO)/QP(9)
GO TO 99
                                                                                                                                                                                             CKOUT
CKOUT
SIZEMR
SIZEMR
SIZEMR
                                                                                                                                                                                                                        99
                                    CHECK CROSS FEED FLAG
                                                                                                                                                                                             SIZEMR
SIZEMR
SIZEMR
SIZEMR
CKOUT
SIZEMR
SIZEMR
SIZEMR
68.
69.
70.
71.
72.
73.
74.
                      1 IF( SE(10).EQ.1.) GO TO 2
            C
C
C
                                    CORRECT ORBITER MASS RATIO
                           SV(6) = (SV(7) + SE(11))/SV(4)
            ECC
                                    CALCULATE BOOSTER MASS RATIO
```

| 76. SV(28) = (VV(1) - SE(11)) / QP(9) 77. C 78. C CHECK SOLID MOTOR FLAG 79. C | CKOUT
SIZEMR
SIZEMR
SIZEMR |
|---|---|
| 80. 2 IF(SQ(20,1).LE.O.) 60 TO 99 81. C 82. C | SIZEMR
SIZEMR
SIZEMR
SIZEMR
CKOUT
SIZEMR
SIZEMR
SIZEMR |
| 88. 99 CONTINUE 89. SQ(14,1) = 32.174 * T827(3) * ALOG(SV(28)) 90. SQ(14,2) = 32.174 * T027(3) * ALOG(SV(6)) 91. SQ(14,2) = 5V(3) 92. SV(2)=5V(3) 93. 999 RETURN END END | SIZEMR CKOUT CKOUT FINI SIZEMR SIZEMR |



SUBRØUT I NE SØL VE



| DESCRIPTION 1 Mess retie | BLOCK
/CINPUT/(| 369) | SUBROUTINE
SUBR CODE | VAR |
|---|---|--|--|--|
| l Mess ratio | /CIMPUT/(| 369) | PRWTSM I | |
| | | | SOLVE I
STORE # | MR
MR
MR
MR |
| E Subroutine to drive meight and volume calculations
(mtsch) to convergence — an inner loop driver | /50LVE /(\$ |) | | SOLVE |
| M Gross weight iteration tolerance | /CINPUT/(| 387) | SOLVE # | TOL |
| M Total body volume | /CIMPUT/(| 391) | SOLVE M
STORE M
TAMPER I
WISCH M | 48004
48004
48004
48004
48004 |
| N Dummy value of vbody in solve routin | /SOLVE /(+ |) | SOLVE M | 41 |
| W. Dummy value of voody in solve routin | /SOLVE /(* |) | SOLVE W | ¥2 |
| M Gross lift-off meight | /CIMPUT/(| 392) | PRWTSM I (SOLVE M STORE M STAMPER I (WTSCH M) | MGROS
WGROS
WGROS
WGROS
WGROS
WGROS |
| S Subroutine to calculate meight and volume of both stages | /WTSCH /(\$ |) | WTSCH E | WTSCH
WTSCH
WTSCH |
| W Dummy value of agross in solve loop | /SOLVE /(+ |) | SOLVE W | W 1 |
| N Dummy value of agross in solve toop | /SOLVE /(+ |) | SOLVE # 0 | w2 |
| | | | CRASH OFFRENCH OFFREN | |
| | M Gross meight iteration tolerance M Total body volume W Dummy value of vbody in solve routin W Dummy value of vbody in solve routin M Gross lift-off meight S Subroutine to calculate meight and volume of both stages W Dummy value of myross in solve loop | M Gross weight iteration tolerance //CINPUT/(M Total body volume //CINPUT/(W Dummy value of vbody in solve routin /SOLVE /(+ M Gross lift-off weight //CINPUT/(S Subroutine to calculate weight and volume of both /WTSCH /(s stages W Dummy value of mgross in solve loop /SOLVE /(+ W Dummy value of mgross in solve loop /SOLVE /(+ C File of all output data //LUN06./(s | M Gross weight iteration tolerance //CINPUT/(387) M Total body volume //CINPUT/(391) M Dummy value of vbody in solve routin //SOLVE /(+) M Gross lift-off meight //CINPUT/(392) S Subroutine to calculate meight and volume of both //MTSCH /(5) stages M Dummy value of mgross in solve loop //SOLVE /(+) M Dummy value of mgross in solve loop //SOLVE /(+) M File of all output data //LUNG6./(5) | M Gross meight iteration tolerance M Total body volume Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body volume A Total body (**) SOLVE /(**) SOLVE M M Dummy value of wbody in solve routin A Total body (**) SOLVE /(**) SOLVE M M Gross lift-off meight A Total body (**) SOLVE /(**) SOLVE M Total body volume A Total body (**) SOLVE /(**) SOLVE M M Dummy value of mgross in solve loop A Total body (**) SOLVE /(**) SOLVE M D Ummy value of mgross in solve loop A Total body (**) SOLVE /(**) SOLVE M D Total body (**) SOLVE /(**) SOLVE M D Total body (**) SOLVE /(**) SOLVE M D Total body (**) SOLVE /(**) SOLVE M D Total body (**) SOLVE M Total body (** |

```
SUBROUTINE SOLVE
THIS VERSION OF SOLVE DRIVES SUBROUTINE WISCH TO CLOSE ON WEIGHT USING A NEWTON/RAPHSON ITERATION SCHEME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SOLVE
SOLVE
SOLVE
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SIZING
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                          C
       2.
3.
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                                                         SING A NEWTON/RAPHSON ITERATION SCHEME

REAL MIN, MAX
REAL MUB MUO ISPB, ISPO, IDVEL, NNB, NO
COMMON / $1ZING/
PHASE II SIZING PARAMERERS
*TZ, VV(3), QP(14), EROR, PZ
*5V(28), SQ(37,5), SE(11), TLAT, T
PHASE I SIZING PARAMERERS
*HBO, WLOD, DMEB, DMEO, T.
*8K1, BK2, BK3, BK4, I
*0K1, BK2, BK3, BK4, I
*0K1, TVACO, NO, WFO, I
*APL, TVACO, NO, WFO, I
*YPL, TVACB, NNB, WEO, WPO, JTYP, BECD, BSTG, DRB1, IT
*SVOP$Q, SVDCON, IHUNT, IOPSTG, IS
REAL KIN, REAL ISP, K, LF, MR, NCREM, LBODY, NPASS
REAL NENGS
*COMMON/CINPUT/
IANENGS ANTANK, ASRATO, ASWEEP, CC30
*COMMON/CINPUT/
IANENGS ANTANK, ASRATO, ASWEEP, CC30
*COMMON/CINPUT/
IANENGS ANTANK, ASRATO, ASWEEP, CC30
*COMMON/CINPUT/
IANENGS ANTANK, ASRATO, ASWEEP, CC50
  8.
9.
10.
                           C
                                                                                                                                                                                                                                                                                              PZ(5),
TLNG,
                                                                                                                                                                                                                                                                                                                                                                                                                         SH(20),
                                                                                                                                                                                                                                                                                                                                                               ٧Đ,
                              C
                                                                                                                                                                                                                                                                                                  TOLWT,
ISIZE,
PRFLG,
IDVEL,
   11.
                                                                                                                                                                                                                                                                                                                                                                                                                         TWRAT2,
TWRATO,
IPSMAX,
ISPB,
                                                                                                                                                                                                                                                                                                                                                              WPB,
TRAFLG,
IPASS,
ISPO,
                                                                                                                                                                                                                                                                                    WEB, WO
VSTG, WPO
ITNBW ITNOW,
,15ZD(19)
                                                                                                                                                                                                                                                                                                                                                                                                                          WLO,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CIMPUT
 20
21.
22.
23.
24.
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CINPUT
CINPUT
                                                       REAL MENSS
COMMON/CIRPUT/
IANNENSS ANTANK ASRATO ASWEEP
2CHBODY CLBODY CSBODY CFAIRST
HISP(6) ITPS K(30) KIN
SMENGS ANISTO MPASS NWL
GRHOFUZ RHOX RHOXZ SBODY
TYTAIL WBODY MGROSS
COMMON/VOLCAL/BBODY CRBOT SHING
2HBODY LBODY RIOD SFAIR
3SPLAN STPS(1) SVERT SWING
4TTOT STORY
5VCREW FUTK FUTK FUTK VINSTK
6VOXTKZ PROP STRUC
COMMON/WICALC/ ABFSYS WABFTK
WABFTK
WASTO WACSTO WACSTK WAERD
3WDISTZ WOOK WDPLOY WORANS
WENGMT WENGS WENGS WARFTK
WENGS WENGS WENGS
SWFUZ(3) WFUEL(6) WFUL WFUITOT
THORY WHYCAD WINFUT
BWJET(6) WHACAT WHOTOT
WHORS WHYCAD WINFUT
BWJET(6) WHACAT WHOTOT
WHORS WHYCAD WORSUL WOVENS
WOOLL WOVENS
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CINPUT
                                                                                                                                                                                                                                                                          C(300) , CBBODY , CFUEL(6), CSFUTK , CSHURZ , CSOXTK , CTHST2 , DEF(5) , FXWOVS , LF , MR(6) , NCREW , PCHAM , TOVERC , TPRATO ,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CINPUT
CINPUT
CINPUT
CINPUT
 28.
29.
30.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CIMPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CINPUT
                                                                                                                                                                                                                                                                           CTIP
SFUTK
SXPOS
VBODY1
                                                                                                                                                                                                                                                                                                                                GAL
SHORZ
TOEL
VBODY2
                                                                                                                                                                                                                                                                                                                                                                                           GSPAN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         VOL CAL
                                                                                                                                                                                                                                                                                                                                                                                     ,GSPAN
,SOXTK
,TROOT
,VCARGO
,VOXTK
 32.
33.
34.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         VOLCAL
VOLCAL
VOLCAL
                                                                                                                                                                                                                                                                              VLGBAY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        VOLCAL
VOLCAL
WTCALC
WTCALC
   35.
                                                                                                                                                                                                                                                                                                                                   , VOTHER
                                                                                                                                                                                                                                                                              WABFU
WAUXT
WCOVER
WDRY
WFCONT
WFUNCT
                                                                                                                                                                                                                                                                                                                                                                                      , WACRES
, WBODY
, WDISTI
, WEMPTY
, WFROST
                                                                                                                                                                                                                                                                                                                                   , WABPR
                                                                                                                                                                                                                                                                                                                                  , WBASIC
, WDECAY
, WELCAD
, WFDCAY
  38
 39.
40.
41.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WTCALC
WTCALC
WTCALC
WTCALC
   42.
                                                                                                                                                                                                                                                                                                                                       WFUOX
                                                                                                                                                                                                                                                                                                                                                                                           WEHRES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WICALC
WICALC
WICALC
WICALC
WICALC
WICALC
                                                                                                                                                                                                                                                                               , WFUTRP
, WINSTK
, WLRD
                                                                                                                                                                                                                                                                                                                                  , WGASPR
, WINST
, WNACEL
  43.
                                                                                                                                                                                                                                                                                                                                                                                       , WGNAV
, WINSUL
                                                                                                                                                                                                                                                                                                                                                                                     , WODCAY
, WOXID
, WOXTRP
, WPOWFO
, WREFUL
   45.
                                                                                                                                                                                                                                                                          WLRD
WOX(6)
WOXTK2
WPPOP
WFROP
WSOPCE
WTPS
WABRES
WPWOTP
                                                                                                                                                                                                                                                                                                                                  , WOX2(3)
, WOXTOT
, WPOWER
, WPRSYS
  48.
                                                                                                                                                                                                                                                                                                                                                                                      , WSTAB
, WWAIT(10),
, WMNFTP
, WGAS
 50.
51.
52.
                                                                                                                                                                                                                                                                                                                                   , WSRTRP
, WVERT
, WMNOTP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        MICALC
WICALC
CKOUT
52.
53.
55.
56.
57.
58.
59.
                                                            TUMNORS WMNFRS WACOTP
BWABFUC WACORS WACFRS
                                                                                                                                                                                                                                                                             WPWOTP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CKOUT
                                                                                                                                                                                                                                                                                                                                       WPWFTP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SOLVE
                                                                IF(SW(13).GT.2.5) WRITE(6,1001)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SOLVE
SOLVE
SOLVE
SOLVE
SOLVE
                                                                WK=MR(3)

IF(TOL.LT.1..OR.TOL.GT.100.) TOL = 5.

ITER =0

MAX=2.5+WGROSS

MIN=0.4+WGROSS
 60.
61.
62.
63.
64.
                       C
                                                                  V1=VBODY
                                                                 W1 = WGROSS
Call WTSCH
  66
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SOLVE
                                                                CONTINUE
DW1=WGROSS-W1
DV1=VBODY -V1
 67.
                                     5005
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SOLVE
 68.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SOLVE
69.
70.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SOLVE
 71.
                                                 10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SOLVE
                                                                W2=WGROSS+WK*DWI
R=W2/WGROSS
V2=VBODY*R
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SOLVE
 73.
74.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SOLVE
```

```
V80DY=Y2

WGR0SS=W2

ITER=ITER+1

CALL WT5CH

DW2=WGR0SS-W2

DV2=V80DY - V2

IF(W2.GT.MAX.OR.W2.LT.MIN) GO TO 120

IF(A85(DW2).LT.TOL.AND.A85(DV2).LT.5.) GO TO 100

IF(ITER GT.15)GO TO 110

WK=(W2-W1)/(DM1-DM2) - 1.

IF(WK.GT.5.) WK=5.

IF(WK.GT.5.) WK=5.

IF(WK.LT.2.) WK=2.

W1 = W2

DW1 = DW2

V1 = V2

DV1 = DV2

IF(SW(13).GT.2.5) WRITE(6,1000) W2,DW2, V2,DV2, WK,ITER

IF(O) 5005, 10,5005

THIS CARD MECESSARY TO PROGRAM AROUND COMPILER

OPTIMIZATION BUG ON UNIVAC 1108 EXEC II.
          7567789012334567899123456
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SOLVE
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100-
110-
          97.
                                                                             110 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SOLVE
 98.
99.
100.
101.
                                                                           100 CONTINUE

IF(SW(13) EQ.2.0) WRITE(6,1001)

IF(SW(13).GT.1.5) WRITE(6,1000) W2,DW2, V2,DV2, WK,ITER

RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SOLVE
SOLVE
SOLVE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SOLVE
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SOLVE
                                                                      120 CONTINUE
WRITE(6,1002)
1002 FORMAT(10X,30H +++++ BLOWUP IN SOLVE +++++ //)
WRITE(6,1001)
102.
103.
104.
105.
106.
107.
108.
109.
110.
111.
                                                                                                                                                                                                                                                                                            WRITE(6,1000) W2,DW2, V2,DV2, WK,ITER
                                                                 RETURN

1000 FORMAT( 5x,2( F12.2,F12.4),F12.3,I4 )
1001 FORMAT(/9x,2HW2 10x,3HDW2 8x, 2HV2 10x, 3HDV2 10x,
1 ZHWK 8x,4HITER )
                                                           C
```



SUBRØUT I NE STØRE

| ORTHAN | MATH | CODE | DESCRIPTION | STORAS | | SUBBOUTIN | |
|--------|--------|-------|---|------------|------|--|--------------------------------------|
| SYMBOL | SYMBOL | | DESCRIFTION | BLOLK | LOC | 503H 100 | E VAR |
| ANENGS | | | mber of air breathing engines used by set0 to set
mmon to zero | /CINPUT/(| 1) | FRENCH I
FRENCH M
SETO O
STORE M
WTSCH I | A
ANENGS
A
ANENGS
ANENGS |
| ANTANK | | M Nu | mber of air breathing fuel tenks | /CINPUT/(| 2) | STORE M
WTSCH I | ANT ANK
ANT ANK |
| ASRATO | | m Wii | ng aspect ratio | /CINPUT/(| 3) | STORE M
WTSCH I | ASRATO
ASRATO |
| ASWEEP | | M Wir | ng leading edge sweep angle | /CINPUT/(| 4) | STORE M
WTSCH I | ASWEEP
ASWEEP |
| С | | M Ing | out array c(300) of vehicle sizing data | /CINPUT/(| 5) | PRINTW I PRITEQ I PRITVA I STORE M WTSCH I WTVOL O | 00000 |
| CBBODY | | м Вос | dy width coeff. | /CINPUT/(| 305) | PRITVA I
STORE M
WTSCH I | CBBODY
CBBODY
CBBODY |
| CFUEL | | M Miz | cture ratio | /CINPUT/(| 306) | PRWTSM M
Store M
WTSCH M | CFUEL
CFUEL
CFUEL |
| CHBODY | | м Вос | ly height or coeff | /CINPUT/(| 312) | PRITVA I
STORE M
WTSCH I | CHBODY
CHBODY
CHBODY |
| CLBODY | | M Bod | ly length or coeff | /CINPUT/(| 313) | PRITVA I
STORE M
WTSCH I | CLBODY
CLBODY
CLBODY |
| CSBODY | | M Tot | al body metted area or coeff | /CINPUT/(| 314) | PRITVA I
STORE M
WTSCH I | CSBODY
CSBODY
CSBODY |
| CSFAIR | | M Fai | ring planform area or coeff | /CINPUT/(| 315) | PRITVA I
STORE M
WTSCH I | CSFAIR
CSFAIR
CSFAIR |
| CSFUTK | | M Fue | I tank surface area or coeff | /CIMPUT/(| 316) | PRITVA I
STORE M
WTSCH I | CSFUTK
CSFUTK
CSFUTK |
| CSHORZ | | M Hor | izontal stabalizer planform area | /CINPUT/(| 317) | PRITVA I
STORE M
WTSCH I | CSHORZ
CSHORZ
CSHORZ |
| CSOXTK | | M Oxi | dizer tank surface area coeff | /CJNPUT/(| 318) | PRITVA I
STORE M
WTSCH I | CSOXTK
CSOXTK
CSOXTK |
| CSPLAN | | m Bod | ly planform arem or coeff | /CINPUT/(| 319) | PRITVA I
STORE M
WTSCH I | CSPLAN
CSPLAN
CSPLAN |
| CSVERT | | M Ver | tical fin planform area or coeff | /CINPUT/(| 326) | PRITVA I
STORE M | CSVERT |
| CSWING | | M Win | g planform area | /CINPUT/(| 321) | STORE M | CSWING |
| CTHRST | | M Vac | . Thrust-to-meight ratio , | /CINPUT/(| 322) | WTSCH I | CTHRST
CTHRST
CTHRST
CTHRST |
| C1H5T2 | | M Sec | ondary propulsion t/m | /CINPUT/(| 323) | PRITVA I
STORE M | CTHST2
CTHST2
CTHST2 |
| FXWOVS | - | M Fix | ed wing loading | /CINPUT/C | 329) | STORE M | FXWOVS
FXWOVS |
| I | | W Do | loop counter | /STORE /(* |) | STORE W | I |



| URTHAN | MATH | CODE | DESCRIPTION | STORA | | | | E USAGE |
|------------|--------|------|---|-----------|------|-------------------------------------|------------------|---|
| 5 Y 14 P L | SYMBOL | | OL SCHITTION | BLOLK | LOC | SUBA | COO | E VAR |
| ISP | | M | Specific impulse | /CINPUT/(| 330) | WTSCH | I
M
I
O | 1SP
1SP
1SP
1SP |
| l TPS | | M | Thermo protection flag | /CINPUT/(| 336) | FRENCH
Store
Wtsch | 0
M
M | ITPS
ITPS
ITPS |
| LF | | M | Ultimate load factor 1. Thrust buildup 2. Not used 3. Main impulse mass ratio 4. Main impulse reserve 5. Secondary impulse mass ratio 6. Not used | /CINPUT/(| 368) | STORE
WTSCH | M
I | LF
LF |
| MR | | M | Mass ratio | /CINPUT/(| 369) | PRWTSM
SOLVE
STORE
WTSCH | I
I
M | ЯР
МЯ
ЯМ
ЯМ |
| NCREW | | M | Number of cres members | /CINPUT/(| 375) | PRITVA
STORE
WTSCH | I
M
I | NCREW
NCREW
NCREW |
| NENGS | | M | Total number engines per stage | /CINPUT/(| 376) | PRITVA
STORE
WTSCH | I
M
I | NENGS
NENGS
NENGS |
| MLISTO | | п | Namelist output flag | /CINPUT/(| 377) | STORE
WTSCH | r
I | NLISTO
NLISTO |
| NPASS | | M | Number of passengers | /CINPUT/(| 378) | | PI
I | NP ASS
NP ASS |
| NWL | | M | Wing loading flag | /CINPUT/(| 379) | | O
M
M | NWL
NWL
NWL |
| PCHAM | | M | Main rocket engine chamber pressure | /CINPUT/(| 380) | STORE
WTSCH | m
I | PCHAM
PCHAM |
| RHOFU | | • | Fuel density | /CINPUT/(| 382) | | I
M
I | RHOFU
RHOFU
RHOFU |
| RHOFU2 | | M | Secondary fuel desnity | /CINPUT/(| 383) | | I
M
I | RHOFU2
RHOFU2
RHOFU2 |
| RHOX | | M | Oxidizer density | /CINPUT/(| 384) | | I
M
I | RHOX
RHOX
RHOX |
| RHOX2 | | m | Secondary oxidizer density | /CINPUT/(| 385) | | I
M
I | RH0 X2
RH0 X2
RH0 X2 |
| SCB | | m | Working name for input c-array booster scaling coefficients . | /ORBINY/(| 144) | SUMOUT
TAMPER
THRUST
VEHOF | ra
I
I | SCB
SCB
SCB
SCB
SCB
SCB
SCB |
| SKB | | M | Working name for input k-array booster volume scaling coeff | /ORBINY/(| 114) | STORE | M | SKB |

* .

| ORTRAN
Symmol | MATH
SYMBOL | CODE | DESCRIPTION | STORAGE
BLOCK | Lec | <u>5 บลคอบ1 1</u>
5 บอค CC | NE USAGE
DE VAR |
|------------------|----------------|--------|--|------------------|-----|--|--|
| SQRT | | F Squa | are root function | /SQRT /(\$ | , | ANLATM FOR CRASH | SORT
SORT
SORT
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SORT |
| STORE | | | outine to store vehicle data in internal format wivol format | /STORE /(\$ |) | FRENCH S
Store | |
| SWING | | M Gros | s wing area | /VOLCAL/(| 17) | PROTHR I
STORE M
WTSCH M | SWING |
| TB10 | | M Stor | ed booster value of csfair | /ORBINY/(| 15) | STORE A | T 810 |
| 7811 | | M Stor | ed booster value of csfutk | /ORBINY/(| 16) | STORE # | TB11 |
| TB12 | | M Stor | ed booster value of csoxtk | /ORBINY/(| 17) | STORE P | TB12 |
| TB13 | | M Stor | ed booster value of cshorz | /ORBINY/(| 18) | STORE A | TB13 |
| TB15 | | M Stor | ed booster value of csplan | /ORBINY/(| 26) | STORE F | TB15 |
| TB16 | | m Stor | ed booster value of csvert | /ORBINY/(| 21) | STORE # | T 816 |
| TB17 | | M Stor | ed booster value of cswing | /ORBINY/(| 22) | STORE # | TB17 |
| TB18 | | M Stor | ed booster value of cthrst | /ORBINY/(| 23) | STORE M | |
| TB19 | | M Stor | ed booster value of cthst2 | /ORBINY/(| 24) | STORE F | TB19 |
| T B 2 | | M Stor | ed booster value of cbbody | /ORBINY/C | 2) | STORE F | TB2 |
| 1827 | | m Stor | ed booster value of isp(i) | /ORBINY/(| 41) | SIZEMR I
SSSP I
STORE M
SUMOUT I
TAMPER I
VEHOF M
WIVOL I | T827
T827
T827
T827
T827 |
| TB34 | | M Stor | ed booster value of mr(i) | /ORBINY/(| 53) | FLYBKP I
ITER8 C
SSSP M
STORE M
SUMOUT I
TAMPER I
VEHDF I
WIVOL M | TB34
TB34
TB34
TB34
TB34
TB34 |
| 1835 | | m Stor | ed booster value of ncrem | /ORBINY/(| 59) | STORE F | T 835 |
| T B 3 6 | | M Stor | ed booster value of nengs | /ORBINY/(| 60) | STORE MESUMOUT I TAMPER I THRUST I WIVOL I | TB36
TB36
TB36 |
| 1838 | | M Stor | ed booster value of npass | /ORBINY/(| 62) | STORE # | TB38 |
| T B 4 | | M Stor | ed booster value of if | /ORBINY/(| 4) | STORE # | TB4 |
| T B 4 1 | | M Stor | ed booster value of rhofu | /ORBINY/(| 65) | STORE # | 1841 |
| T B 4 2 | | M Stor | ed booster value of rhofu2 | /ORBINY/(| 66) | STORE M | TB42 |
| T 8 4 3 | _ | M Stor | ed booster value of rhox | /ORBINY/(| 67) | STORE # | TB43 |
| T B 4 4 | | M Stor | ed booster value of rhox2 | /ORBINY/(| 68) | STORE # | TB44 |

| ORIBAN | MATH | SYMBOL CODE DESC | | DESCRIPTION | STORAS | | SUBBOUTINE U | | |
|---------|--------|------------------|-----------|-------------------|-----------|------|---|-------------|--|
| SYMBOL | SYMBOL | | | DE SCRITTION | BLOCK | LOC | 5 U A H | COU | VAR |
| | | _ | | | | | | | |
| T845 | | M Store | booster | value of saing | /VANIBAO/ | 69) | STORE | M
I | TB45
TB45 |
| | | | | | | | TAMPER | | TB45 |
| T B 4 7 | | M Store | l booster | value of towers | /ORBINY/(| 71) | STORE | M | TB47 |
| T 85 | | M Store | i booster | value of chbody | /ORBINY/(| 10) | STORE | M | T 8 5 |
| T851 | | M Store | booster | value of vbody | /ORBINY/(| 102) | STORE | M
O | TB51
TB51 |
| TB52 | | 0 Store | booster | value of vfutk | /ORBINY/(| 103) | STORE | | TB52 |
| T B 5 3 | | M Stores | booster | value of vfutk2 | /ORBINY/(| 104) | STORE | m | TB53 |
| T B 5 4 | | 0 Stored | booster | value of voxtk | /ORBINY/(| 105) | STORE | 9 | T854 |
| T B 5 5 | | M Stored | booster | value of voxtk2 | /ORBINY/(| 106) | STORE | m | T B 5 5 |
| T B 5 6 | | M Stored | booster | value of #gross | /ORBINY/(| 107) | STORE
WTVOL | M | TB56
TB56 |
| T B 6 | | M Stored | hooster | value of cloody | /ORBINY/(| 11) | STORE | | TB6 |
| TOVERC | | | | over choord ratio | /CINPUT/(| | PROTHR | | TOVER |
| | | | | | 701 | ••• | STORE
WTSCH | M | TOVERO |
| T010 | | M Stored | orbiter | value of csfair | /ORBINX/(| 15) | STORE | M | T010 |
| TG11 | | M Stored | orbiter | value of csfutk | /ORBINX/(| 16) | STORE | M | T011 |
| T012 | | M Stored | orbiter | value of csoxtk | /ORBINX/(| 17) | STORE | P | T012 |
| T013 | | M Stored | orbiter | value of cshorz | /ORBINX/(| 18) | STORE | M | T013 |
| T015 | | M Stored | orbiter | value of csplan | /ORBINX/(| 20) | STORE | m | T015 |
| T016 | | M Stored | orbiter | value of csvert | /ORBINX/(| 21) | STORE | m | T016 |
| T017 | | M Stored | orbiter | value of csming | /ORBINX/(| 22) | STORE | M | T017 |
| T018 | | M Stored | orbiter | value of cthrst | /ORBINX/(| 23) | STORE
WT VOL | | T018
T018 |
| T019 | | M Stored | orbiter | value of cthstz | /ORBINX/(| 24) | STORE | M | T019 |
| T02 | | M Stored | orbiter | value of cbbody | /ORBINX/(| 2) | STORE | M | 102 |
| 1027 | • | M Stared | orbiter | value of isp(i) | /ORBINX/(| 41) | SIZEMR
SSSP
STORE
SUMOUT
VEHOF
WTVOL | I
M
I | T027
T027
T027
T027
T027
T027 |
| T034 | | M Stored | orbiter | value of mr(i) | /ORBINX/(| 53) | ITER8
SSSP
STORE
TAMPER
VEHOF
WIVOL | M
I
O | T034
T034
T034
T034
T034
T034 |
| 1035 | | M Stored | orbiter | value of ncrem | /ORBINX/(| 59) | STORE | M | T035 |
| 1036 | | M Stored | orbiter | value of nengs | /ORBINX/(| 60) | STORE
SUMOUT
TAMPER
THRUST
WTVOL | I
1
1 | T036
T036
T036
T036
T036 |
| T038 | | M Stored | orbiter | value of npass | /ORBINX/(| 62) | STORE | | T038 |
| T04 | | M Stored | orbiter | value of cfuel(1) | /DRBINX/(| 4) | STORE | m | T04 |
| T041 | | M Stored | orbiter | value of rhofu | /ORBINX/(| 65) | STORE | M | T041 |
| 1042 | | M Stored | orbiter | value of rhofu2 | /ORB1NX/(| 66) | STORE | M | T042 |
| T043 | | | | value of rhox | /ORBINX/(| | STORE | | T043 |
| 1045 | | | | value of swing | /ORBINX/(| | STORE
SUMOUT | I | T045
T045 |
| - | | | | | | | TAMPER | | T045 |
| 1047 | | _ | | value of toverc | /ORBINX/(| 71) | STORE | M | T 0 4 7 |
| T 0 5 | | M Stored | orbiter | value of chbody | /ORBINX/(| 10) | STORE | m | T05 |

| URTRAN | MAIH | CODE DESCRIPTION | STORAGE | | SUBROUTINE USAGE | | |
|---------|--------|--|------------|------|--|------------------|--|
| SYMHOL | SYMBOL | OE SCHILLION | BLÚCK | LOL | SUBR | 000 | E VAR |
| T 0 5 1 | | M Stored orbiter value of vbody | /0881NX/(| 1021 | STORE
WT VOL | m
O | TQ51
TQ51 |
| 1052 | | O Stored orbiter value of vfutk | /ORBINX/(| 103) | STORE | 0 | T052 |
| 1053 | | M Stored orbiter value of vfutk2 | /ORBINX/(| | STORE | m | T053 |
| 054 | | D Stored orbiter value of voxtk | /ORBINX/(| 105) | STORE | 0 | T054 |
| 1055 | | M Stored orbiter value of voxtk2 | /ORBINX/(| 106) | STORE | M | 1055 |
| 1056 | | M Stored orbiter value of agross | /ORBINX/(| 107) | STORE
WT VOL | M | T056
T056 |
| 106 | | M Stored orbiter value of cloody | /ORBINX/C | 11) | STORE | M | T06 |
| 066 | | M. Working name for input k-array orbiter volume scaling coeff | /ORBINX/(| 114) | STORE | Ħ | 1066 |
| 707 | | M Stored orbiter value of csbody | /ORBINX/(| 12) | STORE | M | T07 |
| TPRATO | | M. Wing taper ratio | /CINPUT/(| 389) | STORE
WTSCH | m
I | TPRATO
TPRATO |
| TTOT | | 1 Total stage vac. Thrust | /VOLCAL/(| 21) | PRITVA
STORE
WTSCH
WTVOL | I
I
M
I | TTOT
TTOT
TTOT
TTOT |
| /B0DY | | M Total body volume | /CINPUT/(| 391) | PRINTV
SOLVE
STORE
TAMPER
WTSCH
WTVOL | M | VBODY
VBODY
VBODY
VBODY
VBODY
VBODY |
| BODYR | | W Vbody to - 2/3 power | /STORE /(* |) | STORE | W | VBODYR |
| /FUTK | | M Total volume of fuel tank | /VOLCAL/(| 29) | PRINTV
STORE
TAMPER
WTSCH | M | VFUTK
VFUTK
VFUTK
VFUTK |
| /FUTK2 | | M Total volume of secondary fuel tank | /VOLCAL/(| 30) | PRINTV
STORE
TAMPER
WTSCH | M
I | VFUTK2
VFUTK2
VFUTK2
VFUTK2 |
| OXTK | | M. Total volume of oxidizer tank | /VOLCAL/(| 34) | PRINTY
STORE
TAMPER
WTSCH | M | VOXTK
VOXTK
VOXTK |
| /0×TK2 | | M Total volu≡e of secondary oxidizer tank | /VÜLCAL/(| 35) | PRINTV
STORE
TAMPER
WTSCH | m
I | VOXTK2
VOXTK2
VOXTK2
VOXTK2 |
| ACRES . | | m Weight of attitude control fuel reserve | /WTCALC/(| 5) | PRINTW
Store
WTSCH | I
M
M | WACRES
WACRES
WACRES |
| IACSF0 | | M Weight of attitude control fuel plus oxidizer | /WTCALC/(| 7) | PRINTW
STORE
WTSCH | Æ | WACSFO
WACSFO |
| AUXT | | I Weight of separation system | /WTCALC/(| 10) | PRINTW | I
I | TXUAW
TXUAW
TXUAW |
| DECAY | | M Thrust decay propellant weight | /WTCALC/(| 18) | PRINTW
STORE | I | MDECAY
MDECAY |
| FROST | | M Frost and ice weight | /WTCALC/(| 33) | PRINTW
Store | | WFROST
WFROST
WFROST |
| FULOS | | A Vented fuel | /WTCALC/(| 44) | PRINTW
STORE
WISCH | I
M | WFULOS
WFULOS |

| FORTRAN | MAIH | CODE | DESCRIPTION | STORAGE | | SUBROUTINE USAGE | | |
|---------|--------|-------|--|-----------|------|--|--|--|
| SYMBOL | SYMBOL | 1,006 | DESCRIFTION | BLULK | LOC | SUBH CODE | VAR | |
| WFURES | | M | Fuel reserve | /WTCALC/(| 47) | PRINTW I
STORE M
TAMPER I
WTSCH M | WFURES
WFURES
WFURES
WFURES | |
| WFUTAP | | М | Trapped fuel weight | /WTCALC/(| 52) | PRINTW I
Store m
wtsch m | WFUTRP
WFUTRP
WFUTRP | |
| WGASPR | | M | Weight of gas and pressurent | /WTCALC/(| 53) | PRINTW I
STORE M
WTSCH M | WGASPR
WGASPR
WGASPR | |
| WGROSS | | M | Gross lift-off meight | /CINPUT/(| 392) | PRINTW I PRWTSM I SOLVE M STORE M TAMPER I WTSCH M WTVOL I | WGROSS
WGROSS
WGROSS
WGROSS
WGROSS
WGROSS | |
| 1314 | | 0 | Jettison weight 1. Ignition to lift-off 2. Not used 3. Jettison during ascent 4. In-orbit jettison wt. 5. Pre-entry jettison wt. 6. Flyback jettison wt. | /WTCALC/(| 62) | PRITVA I
PRWTSM M
STORE O
TAMPER I
WTSCH M | MJET
MJET
MJET
MJET | |
| MOXLOS | | M | Vented oxidizer | /WTCALC/(| 88) | PRINTW I
Store M
WTSCH M | WOXLOS
WOXLOS
WOXLOS | |
| WOXRES | | M | Oxidizer reserve | /WTCALC/(| 89) | PRINTW I
STORE M
TAMPER I
WTSCH M | WOXRES WOXRES WOXRES WOXRES | |
| WOXTRP | | M | Trapped oxidizer meight | /WTCALC/(| 94) | PRINTW I
STORE M
WTSCH M | WOXTRP
WOXTRP
WOXTRP | |
| WP0WF0 | | M | Power system propellant wt. | /WTCALC/(| 101) | PRINTW I
STORE M
WTSCH M | WP0WF0
WP0WF0
WP0WF0 | |
| WPOWR5 | | M | Power system propellant reserve | /WTCALC/(| 102) | PRINTW I
STORE M
WTSCH M | MPOWRS
MPOWRS
MROGW | |
| WSRTRP | | M | Trapped oxidizer weight | /WTGALC/(| 114) | PRINTW I
STORE M
WTSCH M | WSRTRP
WSRTRP
WSRTRP | |
| WWA1 T | | | Summary meights 1. Ignition 2. Take-off 3.
Burnout 4. Initial orbiter 5. Initial entry 6.
Initial flyback 7. Landing | /WTCALC/(| 122) | PRITVA I
PRWTSM I
STORE M
TAMPER I
WTSCH M | TIAUW
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TIAUW | |

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STORE
                                                                                                          SUBROUTINE STORE
         2.
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                                                                                                            SYNTHESIS CONTROL SUBROUTINE FOR TWO-STAGE VEHICLES
                                                                                                          REAL KIN
REAL ISP,K,LF,MR,NCREW,LBODY,MPASS
REAL NENGS
COMMON/CINPUT/
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CSVERT
ITPS
NLISTO
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CTHST2
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PCHAM
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CSOXTK
FXMOVS
NCREM
                                                                                                   IANENGS
2CHBODY
3CSPLAN
4ISP(6)
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CSBODY
CSWING
K(30)
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CSFAIR
CTHRST
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,CSHORZ
,DEF(5)
,MR(6)
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,TPRATO
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, SHORZ
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                                             ε
                                                                                                   SMING-CSMING
IF(CSMORZ.GT.20.) CSMORZ=CSMORZ/SMING
V8DDYR = 1./(V8DDY**.666667)
IF(CSBDDY.GT.20.) CSBDDY*CSBDDY*VBDDYR
IF(CSBDDY.GT.20.) CSPDDY*CSBDDY*VBDDYR
IF(CSPLAN.GT.20.) CSPLAN-CSPLAN*VBDDYR
IF(CSPLAN.GT.20.) CSPLAN-CSPLAN*VBDDYR
V8DDYR = SQRT(V8DDYR)
IF(CBBDDY.GT.5.) CBBDDY = CBBDDY*VBDDYR
IF(CBBDDY.GT.5.) CBBDDY = CBBDDY*VBDDYR
IF(CBBDDY.GT.5.) CBBDDY = CBBDDY*VBDDYR
IF(CBBDDY.GT.20.) CLBDDY*CBDDY*VBDDYR
IF(CLBDOY.GT.20.) CLBDDY*CLBDDY*VBDDYR
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C ORBITER DATA STORAGE

EMPAY DASTO

TO 2 = CRBODY

00 20 1 = 1,6
20 TOWLEST DESCRIPTION

TO 6 = CLBODY

TO 10 = CSBODY

TO 10 = CSBODY

TO 10 = CSBOTE

TO 11 = CSBOTE

TO 12 = CSBOTE

TO 13 = CSBOTE

TO 13 = CSBOTE

TO 14 = CSBOTE

TO 15 = CSPLAM

TO 16 = CSBOTE

TO 18 = CSBOTE

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TO 18 = CSBOTE

TO 19 = CTHST2

00 24 T = 15 P(1)

24 TO 27(1) = 15 P(1)

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CSBODY = TO7
CSFAIR = TO10
CSFUTK = TO11
CSOXTK = TO12
CSHORZ = TO13
CSPLAM = TO15
CSVERT = TO16
CSWING = TO17
CTHRST = TO18
CTHRST = TO18
204 ISP(1) = 1027(1)
DO 2061 = 16
206 MR(1) = T034(1)
NCREW = T035
NENGS = T036
NPASS = T036
NPASS = T038
RHOFU = T041
RHOFUZ = T042
RHOX = T042
RHOX = T043
RHOX = T043
RHOX = T043
RHOX = T045
T046
T047
VBODY = T047
VBUTK = 0.
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MPASS = 1038
RHOFU = 1041
RHOFU2 = 1041
RHOFU2 = 1042
RHOX = 1043
HHOX2 = 1049
SMIM6 = 1045
TOYERC = 1051
TOYERC = 1051
TOYERC = 1053
TOYERC = 1055
WBOY = 1051
TOYERC = 1055
WBOY = 1055
WBOYS = 1056
OO 230 | 1 | 30
230 ((1) = SKO(1)
OO 260 | = 1,300
260 ((1) = SCO(1)
LF = 1059
TPAATO=1060
ASRA10=1061
FXMOYS=1062
RML=1063
ITFS=1066
ANERNE=1067
ATTAIL=1068
ALLISTO=1069
ASMEP=1070
MFAOST=1071
MFUTRP=1072
MOXIRP=1072
MOXIRP=1073
MSRTP=1074
MDECAY=1076
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03. CSPER = T816
05. CSPER = T816
06. CIMST = T818
06. CIMST = T818
06. CIMST = T818
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19. DO 3061 = 1,6
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11. MCREE = T835
12. MCREE = T835
13. MPASS = T835
14. MCREE = T835
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18. MHOFU = T843
19. RMOFU = T843
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SUBRØUT I NE SUMØUT

| FORTRAN
Symbol | MATH
Symbol | COO | DESCRIPTION | BLOCK | GE
LOC | SUBROUTI
SUBR CO | |
|-------------------|----------------|-----|--|--------------|------------|--|--|
| вттот | | 1 | Total booster meight flow | /TAMP /{ | 5) | SUMBUT I
TAMPER I
WTVOL D | 81101
81101
81101 |
| FRANK | | w | Total ascent propellant weight including for | /SUMBUT/(| ,) | SUMBUT W | FRANK |
| 1 F I R E | | | Integer value of fire flag | /SUMBUT/(| +) | SUMOUT M | IFIRE |
| TOTTO | | 1 | Total orbiter thrust | /TAMP /(| 2) | SUMBUT I
TAMPER I
WTVOL M | 01101
01101
01101 |
| 840082 | | I | Tatel body metted area- baoster | /SUMVW /(| 13) | SUMOUT I | SBODY
SBODY |
| SBODYO | | 1 | Total body metteo area- orbiter | /SUMVW /(| 26) | SUMOUT 1
TAMPER 0 | SBODY |
| SCB | | ī | Working name for input c-array booster scaling coefficients | /ORBINY/(| 144) | FLYBKP M
STORE M
SUMOUT I
TAMPER I
THRUST M
VEHOF I
WTVOL M | SCB
SCB
SCB
SCB
SCB
SCB |
| \$E | | I | Array of synthesis iteration propulsion parameters | /\$1Z1NG/(| 259) | FLYBKP OPRIT VA I SIZEMR I SUMOUT I TAMPER M THRUST M WESCH I WTVOL M | SE
SE
SE
SE
SE
SE
SE
SE |
| SPLANB | | 1 | Booster body planform area | /\$UMVW /(| 14) | SUMOUT I
TAMPER O | SPLAN: |
| SPLANO | | 1 | Orbiter body planform area | /SUMAM \(| 27) | SUMOUT I
TAMPER D | SPLAN
SPLAN |
| SPSLN | | W | Nominal specific impulse- sem level | /SUMOUT/(* | •) | SUMDUT W | SPSLM |
| SPVAN | | W | Nominal specific impulse- vacuum | /SUMBUT/(4 | , , | SUMOUT W | SPVAN |
| SQ | | • | A synthesis data array (37,5) that contains the flyback data and some injection quantities | /SIZING/(| (4) | ENVPRM M ISPRAT I POBC I RANGE M REIZE M SIZEN M STAU I SUMOUAR M STAU I SUMOUAR M TAMPER M T | 89999999999999999999999999999999999999 |
| SUMOUT | | £ | Subroutine to print summary data and calculate thrust for output purposes only | /SUMOUT/(\$ |) | SSSP S
SUMOUT E | SUMOL |

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAG
BLOCK | LOC | SUBROUTINE
SUBR CODE | USAGE |
|-------------------|----------------|----------|---|-----------------|--------|--|--|
| 3111000 | 31 HBUL | | | OCUUN | | 3000 0000 | . V M M |
| SV | | 1 | A synthesis array (28) containing staging parameters and misc flags | /51z1NG/(| 46) | FLYBKP I
ITER8 I
RANGE I
SIZEMR M
SIZIN I
SSSP I
SUMDUT I
TAMPAR O
FAMPER M
TRIOSZ M
VENDF M | 24444444444444444444444444444444444444 |
| 1827 | | ĭ | Stored booster value of isp(i) | /ORBINY/(| 41) | STORE M
SUMOUT I
TAMPER I
VEHDF M | 1827
1827
1827
1827
1827
1827
1827 |
| T834 | | Ī | Stored booster value of ar(1) | /ORBINY/(| 53) | ITERS O
SSSP M
STORE M
SUMOUT I
TAMPER I
VEHOF I | TB34
TB34
TB34
TB34
TB34
TB34
TB34 |
| TB36 | | J | Stored booster value of mangs | /ORB] MY/(| 60) | SUMOUT 1
TAMPER 1
THRUST 1 | TB36
TB36
TB36
TB36
TB36 |
| TB45 | | I | Stored booster value of swing | /ORBINY/(| 69) | SUMOUT I | TB45
TB45
TB45 |
| 1027 | | 1 | Stored orbiter value of isp(i) | /DFBINX/(| ,
, | SSSP I
STORE M
SUMOUT I
VEHDF M | T027
T027
T027
T027
T027
T027 |
| T036 | | ſ | Stored orbiter value of nengs | /XRBINX/(| 60) | SUMOUT I
TAMPER I
THRUST I | 1036
1036
1036
1036 |
| 1045 | | 1 | Stored orbiter value of saing | /GRBINX/(| 693 | SUMOUT I | 1045
1045
1045 |
| TSLN | | ₩ | Nominal sea level thrust for output | /SUMOUT/(# |) | SUMBUT # 1 | FSLM |
| TSLNB | | ᄖ | Nominal sea level thrust for output booster | /SUMBUT/(+ |) | SUMOUT W 1 | SLNB |
| TSLNO | | ㅂ | Nominal sea level thrust for output orbiter | /SUMOUT/(# |) | SUMBUT W 1 | SLNO |
| TVAN | | ы | Nominal vac. Thrust-output (vehicle) | /SUMOUT/(+ |) | SUMBUT W T | VAN |
| TVANB | | u | Nominal vac. Thrust-output (booster) | /SUMOUT/(# |) | รบคอยา ม 1 | VANB |
| T VANO | | W | Nominal vac. Thrust-output (orbiter) | /SUMBUT/(* |) | SUMBUT # 1 | GHAV |
| T MORB | | u | Orbiter thrust-to-weight ratio | /SUMDUT/(+ |) | SUMBUT W 1 | BRGM |
| VB00YB | | 1 | Booster body volume | /SUMVW /(| | | BODYB |
| VBODYO | | I | Orbiter body volume | /SUMVW /(| | | B00Y0 |
| | | | | /SUMVW /(| 22) | | CARD |

| FORTRAN | MATH | CODE DESCRIPTION | STORAG | | SUBROUTIN | E USAGE |
|-------------|--------|---|------------|-----|---------------------------------|----------------------------|
| SYMBOL | SYMBOL | DESCRIPTION | BLOCK | FOC | SUBR COD | E VAR |
| VFUTKB | | I Total valume of fuel tank - booster | /SUMVW /(| 7) | SUMBUT 1
TAMPER O | VFUTKB
VFUTKB |
| VFUTKO | | I Total volume of fuel tank — orbiter | /SUMVW /(| 20) | SUMBUT I
TAMPER D | VFUTKO
VFUTKO |
| VOTHB | | I Misc. Booster volume | /5UMVW /(| 9) | SUMOUT I
TAMPER O | VOTHB
VOTHB |
| 0HT0V | | I Misc. Orbiter valume | /SUMVW /(| 23) | SUMOUT 1
TAMPER 0 | OHTOV |
| VOXTKB | | I Booster oxidizer tank volume | /SUMVW /(| 8) | SUMOUT I | VOXTER |
| VOXTKO | | I Orbiter oxidizer tank volume | /SUMVW /(| 21) | SUMOUT I
TAMPER O | VOXTKO
VOXTKO |
| VPROPB | | W Volume of propulsion bay - booster | /SUMBUT/(+ |) | SUMBUT W | VPROPB |
| VPROPO | | W Volume of propulsion bay - orbiter | /SUMOUT/(# |) | SUMDUT W | VPROPO |
| MABFUB | | I Booster flyback fuel required | /SUAVW /(| 2) | SUMOUT I
TAMPER M | WABFUB
Wabfub |
| WABFUG | | I Orbiter flyback fuel required | /SUMVW /(| 19) | SUMBUT I
TAMPER M | WABFUO
Wabfuo |
| WBPTX | | W Ascent propellant weight - booster | /SUMOUT/(+ |) | SUMOUT W | WBPTX |
| MCGNTB | | I Contingency and growth meight-boostr | /SURVW /(| 36) | SUMOUT I
TAMPER O | WCONTB
WCONTB |
| MCONTO | | I Contingency and growth meight-orbitr | /SUMVW /(| 37) | SUMOUT I
Tamper o | WCONTO
WCONTO |
| MODTN | | W Nominal weight flow | /SUMBUT/(* | } | SUMDUT W | WDBTW |
| HDRYB | | I Stage dry weight - booster | \ZUMAM \(| 4) | SUMOUT 1
TAMPER 0 | MDRYB |
| DRYD | | I Stage dry weight -orbiter | /SUAVW /(| 17) | SUMDUT I
Tamper o | WDRYO
WDRYO |
| WENTRB | | 1 Booster entry weight | /SUMVW /(| 34) | SUMBUT 1
Tamper 0 | WENTRB
WENTRB |
| WENTRO | | I Orbiter entry meight | /SUMVW /(| | SUMDUT I
Tamper D | WENTRO
WENTRO |
| 4FUOXB | | 1 Propeliant at. Less fpr -booster | /SUMVW /(| | SUMOUT I
Tamper m | WFU0XB
WFU0XB |
| NF UO XO | | I Propeliant st. Less fpr -orbiter | /TAAP /(| _ | SUMOUT I
TAMPER I
WTVOL M | #FU0X0
#FU0X0
#FU0X0 |
| 4GROSB | | I Booster gross meight | /SUMVW /(| | SUMOUT I
Tamper m | WGROSB
WGROSB |
| IGROSO | | I Orbiter gross meight | /TAMP /(| | SSSP I
SUMOUT I
WTVOL M | WGROSO
WGROSO
WGROSO |
| LANDB | | I Landing welght - booster | /SUMVW /(| | SUMDUT I
TAMPER D | WLANDB
Wlandb |
| LANDO | | l Landing meight - orbiter | /SURVW /(| | | WLANDO
WLANDO |
| 40 P | | I Orbit maneuvering propellant meight | /SUMVW /(| | | #0P |
| IOPT | | ₩ Total ascent propellant weight | /SUMBUT/(+ | 3 | | HOPT |
| IOPTX | | W Ascent propellant for orbiter including fpr | /SUMBUT/(+ |) | SUMDUT W | MOPTX |
| ORBTO | | I In-orbit weight - orbiter | /SUMVW /(| | TAMPER O | WORBTO
WORBTO |
| ЮТИВ | | I Misc Weight - booster | /SUMVW /(| | TAMPER 0 | WOTHB
WOTHB |
| 10 T HD
 | | I Misc. Weight - orbiter | /SUAVW /(| | TAMPER O | OHTOW
OHTOW |
| IO VRSB | | I Booster wing loading | /SUMVW /(| | | WOVRSB
WOVRSB |

8 NOV 72 6.01-46

| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAGE
BLOCK L | SUBROUTINE USAGE |
|-------------------|----------------|-------|----------------------|--------------------|---|
| 314600 | 311000 | | | DCUCK C | JC 3004 CODE VAN |
| MO VRSO | | 1 Ort | iter ming loading | /SUMVW /(| 28) SUMOUT I WOVASO
TAMPER O WOVASO |
| MP AY LO | | I Pay | load weight | /SUMVW /(| 16) 555P I WPAYLO
SUMOUT I WPAYLO
TAMPER M WPAYLO |
| MRTRNB | | I Ent | ry weight- booster | /SUMVW /(| 32) SUMOUT I WATENS
TAMPER D WETENS |
| WRTRNO | | I Ent | ry meight- orbiter | /SURVW /(| 31) SUMOUT I WATENO
TAMPER D WATENO |
| .UNO6. | | O Fil | e of all output data | /.UN06./(\$ | BLICD |

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SUBROUTINE SUMOUT
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SUMOUT
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                                                                                                                                                                         SUBROUTINE TO PRINT SUMMARY DATA CALCULATES THRUST FOR OUTPUT PURPOSES ONLY
                                                                                                  REAL LBDDYD, LBDDYB

REAL MUB, MUD, ISPB, ISPD, IDVEL, NNB, NO

COMMON / SIZING/
PHASE II SIZING PARAMERERS

*IZ, VV(3), GP(14), ERGR, PZ(5), VG, SW(20),

*SV(28), SQ(37,5), SE(11) TLAT, TLNG,
PHASE I SIZING PARAMERERS

*WBD, MLDO, DWEB, DWED, TOLWT, WPB, TWRAT2,
*BK1, BK2, BK3, BK4, ISIZE, TRAFLG, TWRAT0,
*CK1, OKZ, OK3, OK4, PRFLG, IPASS, IPSMAX,
*AEXIT, TVACD, NO, WFD, 10VEL, ISPO, ISPB,
*VPL, TVACB, NNB, MED, WEB, MD, WLO,
*DVD, DVB, MUB, MUD, VSTG, MPO
*JIVP, BCCD BSTG, ORBI, ITNBW, ITNDW,
*SVDPSQ, SVDCON, IHUNT, 10PSTG, ISZD(19)
*OIMENSION SKG(30), SCG(300, T04(6), T020(10), T027(6), T034(6),
*T048(10), T049(10), T050(10), T057(6), OWSAVE(10)
*COMMON/ORBINX/
*T011, T02, T03, T04, T05, T06, T07, T08, T09, T010, T011, T012, T013, T014,
*T041, T042, T043, T044, T045, T046, T047, T048, T049, T050, T051, T052, T053,
*T044(10, T047, T048, T047, T048, T049, T050, T051, T052, T053,
*T041, T042, T043, T044, T045, T046, T047, T048, T049, T050, T051, T052, T053,
*T057, T058, T055, T056, T057, T068, T067, T068, T069, T070, T071,
*T072, T073, T074, T075, T076, T077, T078, T079, T080, T081, T082, T083,
*T0848(10), T849(10), T850(10), T857(12, DASPE, CA, TB49(10), TB34(6),
*T1848(10), T849(10), T850(10), T857(12, DASPE, CA, TB49(10), TB34(6),
*T1848(10), T849(10), T850(10), T857(12, DASPE, CA, TB49(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), TB37(10), 
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WLO, SIZING
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                                                                                 6, TOS9, TO60, TO61, TO62, TO63, TO64, TO65, TO67, TO68, TO69, TO70, TO71, TO72, TO73, TO74, TO75, TO76, TO77, TO78, TO79, TO80, TO81, TO82, TO83, BT084

DIMENSION SK8(30), SCB(300), TB4(6), TB20(10), TB27(6), TB34(6), TB48(10), TB48(10), TB49(10), TB50(10), TB57(6), BMSAVE(10)

COMMON/ORBINY

T B1, TB2, TB3, TB4, TB5, TB6, TB7, TB8, TB9, TB10, TB11, TB12, TB13, TB14, TB15, TB16, TB17, TB18, TB15, TB22, TB23, TB34, TB35, TB36, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB38, TB37, TB37, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, TB77, TB78, T
    31.
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SUMBUT
                                                                                                                     TSLNB = TVANB * TB27(2)/TB27(3)
x = 1.
1F(SE(8).EQ.O..OR.IFIRE.EQ.2)  x=0.
TVAN = OTTOT * X + BTTOT
WOOTN = OTTOT * X / FORTOT
SPVAN = TVAN/WOOTN
TSLN = TSLN/WOOTN
TSLN = TSLN/WOOTN
WOPT = FSLN/WOOTN
WOPT = FRANK + SQ(37,4)
WOPTX = WFUOXO + SQ(37,4)
WBPTX = WFUOXO + SQ(37,5)
ACOPIE = SV(15) + .1
DO 900 J=1, NCOPIE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            SUABUT
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WRITE (6,1000)

WRITE (6,1005)

WRITE (6,1011)

WRITE (6,1011)

WRITE (6,1012)

WRITE (6,1012)

WRITE (6,1012)

WRITE (6,1012)

WRITE (6,1012)

WRITE (6,1020)

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                                                                            TO THIS CONTINUE

WRITE (6,2112) TSLMB, TSLMO, TSLM

WRITE (6,2113) TYMAB, TYMANO, TYMAM

WRITE (6,2113) TYMAB, TYMANO, TYMAM

WRITE (6,2115) SPSLM

WRITE (6,1125) SPSLM

WRITE (6,1126) TB39(3),5V(6)

WRITE (6,1126) TB39(3),5V(6)

WRITE (6,1126) SQ(14,1),5Q(14,3),5Q(14,2)

WRITE (6,1127) SE(6)

WRITE (6,1130) SV(12)

WRITE (6,1130) SV(12)

WRITE (6,1140) SV(9)

WRITE (6,1145) SV(10)

WRITE (6,1155) SQ(14,4)

WRITE (6,1155) SQ(14,5)

WRITE (6,1165) SQ(15,4)

WRITE (6,1165) SQ(15,4)

WRITE (6,1165) SQ(15,4)

WRITE (6,1165) SQ(15,4)
                                                      200 CONTINUE
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                                                         900 CONTINUE
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                                                                               CONTINUE
WRITE (6,1000)
WRITE (6,3000) 50(36,1)
WRITE (6,3010) 50(36,2)
WRITE (6,3015) 50(36,2)
WRITE (6,3020) 50(36,4)
WRITE (6,3020) 50(36,4)
WRITE (6,3025) 50(36,5)
WRITE (6,3046) 50(37,2)
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| 150. | WRITE (6,3050)
IFLY = \$0(19,5) | SUMOUT |
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| 151.
152. | 1FLY = 50(19,5)
GD TO (910,920,930,940,950),1FLY | \$UMOUT
\$UMOUT 910 |
| 153
154. | 910 WRITE (6,3055) SM(9),SQ(10,2)
GO TO 960 | SUMDUT 960— |
| 155.
156. | 920 WRITE (6,3060) SV(12)
GO TO 960 | SUMDUT
SUMDUT 960 |
| 157. | 930 WRITE (6,3065) \$Q(10,3) | SUMOUT |
| 158. | GO TO 960
940 WRITE (6,3070) SW(10),SQ(12,1) | SUMBUT 960— |
| 160. | GO TO 960
950 WRITE (6,3075) SV(27) | 50M0UT 960- |
| 162. | WRITE (6,3085) TLAT
WRITE(6,3085) TLNG | SUMOUT
SUMOUT |
| 164.
165. | WRITE (6.3090) PZ(5) | SUMOUT
SUMOUT |
| 166 | WRITE (6,3095) PZ(3)
WRITE (6,3100) PZ(1)
WRITE (6,3105) PZ(2) | SUMBUT |
| 167 | WRITE (6,3110) PZ(4) | SUMOUT SUMOUT |
| 169. | 960 1FUL = \$Q(32,1)
GO TO (965,970,975),1FUL | SUMOUT 965 |
| 171. | | SUMOUT |
| 172.
173 | 965 WRITE (6,3115) SW(15) WRITE (6,3120) SW(12) WRITE (6,3125) SW(11) | SUMBUT
SUMBUT |
| 174.
175. | WRITE (6,3130) 5W(14) | SUMOUT
SUMOUT |
| 176. | WRITE (6,3135) SQ(10,3)
WRITE (6,3140) SQ(32,4) | SUMOUT |
| 177.
178. | W2 = WABFUB - 50(32,4) | SUMOUT |
| 179 | WRITE (6,3145) W2
WRITE (6,3150) WABFUB
WRITE (6,3155) SCB(214) | SUMOUT |
| 180.
181. | WRITE (6,3155) SCB(214)
GD TO 980 | SUMBUT 980-7 |
| 182. | 970 WRITE (6,3160) SW(15) | SUMOUT |
| 183. | WRITE (6,3175) 5Q(32,5) | SUMOUT SUMOUT |
| 185 | WRITE (6,3165) SQ(32,2)
WRITE (6,3180) SQ(33,1) | SUMOUT |
| 186
187 | WRITE (6,3215) \$0(35,2)
WRITE (6,3190) \$0(33,4) | SUMBUT
SUMBUT |
| 188 | WHITE (6,3179) 5 U (34,2) | SUMOUT |
| 189.
190 | WRITE (6,3200) SQ(34,5) | SUMDUT
SUMDUT |
| 191 | WRITE (6,3205) SQ(35,5) WRITE (6,3220) SQ(35,3) | SUMOUT |
| 192 | WRITE (6,3170) 50(32,3) | SUMOUT SUMOUT |
| 194 | WRITE (6,3185) SQ(33,2)
WRITE (6,3225) SQ(35,4) | SUMOUT |
| 195.
196. | WRITE (6,3225) \$8(35,4)
WRITE (6,3135) \$8(10,3)
WRITE (6,3210) \$8(32,4) | TUOKUZ
TUOKUZ |
| 197. | WRITE (6,3150) WABFUB | SUMBUT |
| 198.
199. | WRITE (6,3155) SCB(214)
GO TO 980 | SUMDUT 980- |
| 200 | 975 WRITE (6,3230) SW(15) | SUMDUT |
| 201. | WRITE (6,3175) 50(32,5) | SUMOUT |
| 202.
203. | WRITE (6,3175) SQ(32,5) WRITE (6,3235) SQ(33,3) WRITE (6,3235) SQ(34,1) WRITE (6,3255) SQ(34,4) | SUMBUT SUMBUT |
| 204. | WRITE (6,3255) SQ(34,4) | SUMOUT |
| 205.
206. | WRITE (6,3180) SQ(33,1)
WRITE (6,3215) SQ(35,2) | SUMDUT
SUMDUT |
| 207 | MRITE (6,3190) 50(33,4) | SUMBUT |
| 208.
209 | WRITE (6,3195) SQ(34,2)
WRITE (6,3200) SQ(34,5) | TUGNUS
TUGNUS |
| 210. | WRITE (6,3205) 50(35,5)
WRITE (6,3220) 50(35,3) | SUMOUT |
| 211.
212 | WRITE (6,3220) SQ(35,3)
Write (6,3240) SQ(33,5) | SUMOUT |
| 213 | ₩RITE (6,3250) SQ(34,3) | SÚMOÚT (|
| 214 | WRITE (6,3260) SQ(35,1)
WRITE (6,3185) SQ(33,2) | SUMOUT
SUMOUT |
| 216 | WRITE (6,3225) SQ(35,4)
WRITE (6,3135) SQ(10,3) | SUMOUT |
| 217.
218. | WRITE (6,3135) SQ(10,3) WRITE (6,3210) SQ(32,4) | SUMBUT
SUMBUT |
| 219. | WRITE (6,3150) WABFUB | SUMOUT |
| 220. | WRITE (6,3155) SCB(214) | SUMOUT 1 |

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221.
222.
223.
                                                                980 CONTINUE
RETURN
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                                                        | 1000 FORMAT(1H1,25X,31MSPACE SHUTTLE SYNTHESIS SUMMARY) | 1005 FORMAT (37X,7MB005TER11X,7MDRBITER11X,7MVEHICLE/) | 1010 FORMAT (12M WEIGHT (LB)) | 1011 FORMAT(32M PROPELLANT, ASCENT LESS FPRF12.0, F18.0) | 1012 FORMAT (3CM PROPELLANT, ASCENT FPR,F17.0,F18.0) | 1020 FORMAT (3CM PROPELLANT, ASCENT TOTAL F14.0,2F18.0) | 1020 FORMAT (3CM PROPELLANT, ORBIT MANEUVER 8X,2F18.0 | 1025 FORMAT (2CM PROPELLANT, TOTAL 3F18.0) | 1030 FORMAT (2CM PAYLOAD 18X,2F18.0 | 1035 FORMAT (2CM STRUCTURE 3F18.0) | 1040 FORMAT (2CM STRUCTURE 3F18.0) | 3F18.0) | 3F18.0) | 1040 FORMAT (2CM STRUCTURE 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.0) | 3F18.
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296. 3065 FORMAT (17H CONSTANT, DRNG = F10.3)
297. 3070 FORMAT (22H IIP, CENTRAL ANGLE = F8.2,5%,5M IIP= F8.2)
298. 3075 FORMAT (38H NUMERICAL INTEGRATION, MAX. LOADING = F7.3)
299. 3080 FORMAT (5%,6MTLAT = F8.3)
300. 3085 FORMAT (5%,6MTLAT = F8.3)
301. 3095 FORMAT (5%,15MSURFACE RANGE = F9.3)
302. 3095 FORMAT (5%,15MSURFACE RANGE = F9.3)
303. 3100 FORMAT (5%,10HLATITUDE = F10.1)
304. 3105 FORMAT (5%,10HLATITUDE = F8.3)
305. 3110 FORMAT (5%,11HLONGTIUDE = F8.3)
306. 3115 FORMAT (5%,11HLONGTIUDE = F8.3)
307. 3120 FORMAT (5%,11HLONGTIUDE = F8.3)
308. 3115 FORMAT (5%,15MSZIMUM DIFF. = F8.3)
307. 3120 FORMAT (5%,5MSZIMUM DIFF. = F8.3)
308. 3125 FORMAT (5%,5MSZIMUM DIFF. = F8.3)
309. 3130 FORMAT (5%,5MSZIMUM DIFF. = F8.2)
309. 3130 FORMAT (5%,5MSZIMUM DIFF. = F9.2)
310. 3135 FORMAT (5%,5MSZIMUM DIFF. = F9.2)
310. 3135 FORMAT (5%,5MSZIMUM DIFF. = F9.2)
311. 3140 FORMAT (5%,7MKLYX = F9.2)
312. 3143 FORMAT (5%,7MKLYX = F9.2)
313. 3150 FORMAT (5%,7MKLYX = F9.2)
314. 3155 FORMAT (5%,7MKLYX = F9.2)
315. 3160 FORMAT (5%,7MKLYX = F9.2)
316. 3165 FORMAT (5%,7MKLYX = F9.2)
317. 3170 FORMAT (5%,7MKLYX = F9.2)
318. 3157 FORMAT (5%,7MKLYX = F9.2)
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319. 3180 FORMAT (5%,5MRLY = F9.2)
319. 3180 FORMAT (5%,5MRLY = F9.2)
319. 3180 FORMAT (5%,5MRLY = F9.2)
320. 3185 FORMAT (5%,5MRLY = F9.2)
321. 3199 FORMAT (5%,5MRLY = F9.2)
322. 3195 FORMAT (5%,5MRLY = F9.2)
323. 3200 FORMAT (5%,5MRLY = F9.2)
324. 3225 FORMAT (5%,5MRLY = F9.2)
325. 3210 FORMAT (5%,7MKLY = F9.2)
326. 3215 FORMAT (5%,7MKLY = F9.2)
327. 3220 FORMAT (5%,7MKLY = F9.2)
328. 3225 FORMAT (5%,7MKLY = F9.2)
329. 3230 FORMAT (5%,7MKLY = F9.2)
331. 3240 FORMAT (5%,7MKLY = F9.4)
332. 3250 FORMAT (5%,7MKLY = F9.4)
333. 3250 FORMAT (5%,7MKLY = F9.4)
336. END
```

SUBRØUT I NE TAMPER

| FORTRAN | MATH | COO | E DESCRIPTION | STORA | | SUBBOU | | |
|----------|--------|-----|--|------------|------|---|------------------|--|
| SYMBOL | SYMBOL | | DESCRIPTION | BLOCK | LOC | SUBR | COO | E VAR |
| BTTOT | | 1 | Total booster weight flow | /TAMP /(| 5) | SUMOUT
TAMPER
WT VOL | | BITOT |
| BWDOT1 | | W | Booster maight flow | /TAMPER/(| •) | TAMPER | ₩ | 84001 |
| IFIRE | | | Integer value of fire fing | /TAMPER/(| • } | TAMPER | ~ | IFIRE |
| LBODY | | I | Body length | /VOLCAL/(| 8) | PROTHR
TAMPER
WTSCH | I | L8001 |
| 01101 | | I | Total orbiter thrust | /TAMP /(| 2) | SUMDUT
TAMPER
WTVOL | | 01101
01101
01101 |
| SBODY | | 1 | Total body metted area | /CIMPUT/(| 386) | PROTHR
TAMPER
WTSCH | I
I | SBOOY |
| SBODYB | | 0 | Total body metted area- booster | /5UMVW /(| 13) | SUMOUT
TAMPER | 1 | 5800Y
5800Y |
| 580040 | | 0 | Total body metted area— orbiter | /SUMVW /(| 26) | SUMBUT | | SBODY |
| S C B | | I | Working name for input c-array booster scaling coefficients | /ORBINY/(| 144) | FLYBKP
STORE
SUMOUT
TAMPER
THRUST
VEHDF
WTVOL | M
M
I
I | 5CB
5CB
5CB
5CB
5CB
5CB
5CB |
| SE | | • | Array of synthesis iteration propulsion parameters | /\$12ING/(| 259) | FLYBKP
PRITYA
SIZEAR
SIZEAR
TAMPER
THRUST
VEHOF
WTSCH
WTYOL | I
I
M | SE
SE
SE
SE
SE
SE
SE
SE
SE |
| PLAN | | I | Body planform area | /VOLCAL/(| 14) | PROTHR
TAMPER
WTSCH
WTVOL | | SPLAN
SPLAN
SPLAN
SPLAN |
| PLANB | | 0 | Booster body planform area | /SUA+W /{ | 14) | SUMOUT
TAMPER | | SPLAN |
| PLAND | | 0 | Orbiter body planform area | /SURVW /(| 27) | SUMBUT
TAMPER | | SPLAN
SPLAN |
| a | | М | A synthesis data array (37,5) that contains the flyback data and some injection quantities . | /S1Z1NG/(| | ISPRAT
PDBC
PRITYA
RANGE
REUS
SIZE
SIZEMR
SIZIN
SIZIN
SUMOUT
TAMPAR
THRUST
TRTOSZ | MIIIMOOMMIMOMM | 50000000000000000000000000000000000000 |

| ORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAG
BLOCK | LOC | SUBROUTIN
SUBR COD | E USAGI |
|------------------|----------------|----------|---|--------------------|-----|---|--|
| 3711802 | 3111000 | | | BLOCK | | JUSK COU | |
| 5 v ' | | | thesis array (28) containing staging eters and misc flags | /S1Z1NG/(| 46) | ENVPRM M FLYBRP I ITERS I RANGE I SIZEMR M SIZIN I SUMOUT I TAMPAR M TATOSZ M VEHOF M VEHOF I | 2222222222
444444444444444444444444444 |
| TAMPER | | | utine to interface weight and volume over
trajectory program overlay | lay /TAMPER/(S |) | TAMPER E | TAMPER |
| 1827 | | | d booster value of Isp(i) | /ORB1 N Y/(| 41) | SUMOUT I
TAMPER I
VEHOF M | T827
T827
T827
T827
T827
T827
T827 |
| 1834 | | I Store | d booster value of mr(1) | /ORBINY/(| 53) | SSSP M
STORE M
SUMOUT I
TAMPER I
VEHDF 1 | T834
T834
T834
T834
T834
T834
T834
T834 |
| 1836 | | I Store | booster value of nengs | /ORBINY/(| 60) | SUMDUT I
TAMPER I
THRUST I | T836
T836
T836
T836
T836 |
| 845 | | 1 Store | l booster value of swing | /ORBINY/(| 69) | SUMBUT I | 3845
1845
1845 |
| (034 | | I Store | l orbiter value of ar(i) | /ORBINX/(| 53) | SSSP 0
STORE M
TAMPER I
VEHOF 0 | T034
T034
T034
T034
T034
T034 |
| 036 | | I Stored | i orbiter value of mengs | /ORBINX/(| | SUMOUT I
TAMPER I
THRUST I | T036
T036
T036
T036
T036 |
| 045 | | I Stored | orbiter value of sping | /ORBINX/(| | SUMOUT I | 1045
1045
1045 |
| 2 | | ⊌ Main e | ngine burn time | /TAMPER/(+ |) | TAMPER W | T2 |
| ABFUB | | 0 Volume | of booster propellant tanks | /SUMVW /(| 11) | TAMPER 0 | VABFUB |
| BODY | | I Totel | body valume | /C1NPUT/(| | SOLVE M
STORE M
TAMPER I
WTSCH M | ABODA
ABODA
ABODA
ABODA
ABODA
ABODA |
| BODYB | | 0 Booste | r body volume | /SUAVW /(| | | 480048
480048 |
| BODYO | | 0 Orbite | r body volume | /SUMVW /(| | | 0 ¥ 0 0 8 ¥
0 ¥ 0 0 8 ¥ |

| DRTRAN | MATH | CODE DESCRIPTION | STORAGE | SUBROUTINE USAGE |
|----------------|--------|---|---------------|--|
| SYMBOL | SYMBOL | DESCRIPTION | BLOCK LDC | SUBR CODE VAR |
| VCARGO | | 1 Volume of cargo bay | /WOLCAL/(27 | PRINTY I VCARGE
TAMPER I VCARGE
MTSCH M VCARGE |
| VCARD | | 0 Volume of cargo | /SUMVW /(22 | SUMOUT I VCARO |
| AENIK | | 1 Total volume of fuel tank | /VOLCAL/(29 | PRINTY I VFUTK STORE M VFUTK TAMPER I VFUTK WTSCH M VFUTK |
| V FUTKB | | O Total volume of fuel tank - booster | /SUMVW /(7: | SUMOUT I VFUTKE |
| IF UT KO | | O Total volume of fuel tank - orbiter | /SUMVW /(201 | SUMOUT 1 VEUTKO |
| IFUTK2 | | 1 Total volume of secondary fuel tamk | /VOLCAL/(30) | PRINTY 1 VFUTK2
STORE M VFUTK2
TAMPER 1 VFUTK2
WTSCH M VFUTK2 |
| OTHB | | O Misc. Booster volume | /SUMVW /(9) | SUMOUT 1 VOTHB |
| 0110 | | 0 Misc. Orbiter volume | /SUAVW /(23) | SUMDUT 1 VOTHO |
| IOXTK | | I Total volume of oxidizer tank | /VOLCAL/(34) | PRINTY I VOXTK
STORE M VOXTK
TAMPER I VOXTK
WISCH M VOXTK |
| OXTKB | | 0 Booster oxidizer tank volume | /SUNVW /(8) | SUMOUT I VOXTKE |
| DXTKO | | O Orbiter oxidizer tank volume | /SUMVW /(21) | SUMOUT I VOXTKO |
| OXTK2 | | I Total volume of secondary oxidizer tank | /WOLCAL/(35) | PRINTY I VOXTK2 STORE M VOXTK2 TAMPER I VOXTK2 WTSCH M VOXTK2 |
| IABFŲ | | I Weight of spfuel | /WTCALC/(3) | PRINTU I WABFU
PRWTS# # WABFU
TAMPER I WABFU
WTSCH # WABFU |
| IABF UB | | M Booster flyback fuel required | /SUAVW /(2) | SUMBUT I MABFUS |
| ABF UD | | M Orbiter flyback fuel required | /SUAVW /(19) | SUMOUT I WABFUO
TAMPER M WABFUO |
| 800 | | 1 Booster gross weight | /JUAP¥ /(3) | PRINTH I MBOO
TAMPER I MBOO
MTVOL O MBOO |
| CONT | | 1 Contingency and growth meight | /WTCALC/(16) | PRINTH I MCONT
TAMPER I MCONT
WISCH M MCONT |
| CONTB | | O Contingency and growth meight-boostr | /SUMVW /(38) | SUMOUT I WCONTB |
| CONTO | | D Contingency and growth weight-orbitr | /SUAVW /(37) | SUMOUT I MCONTO |
| 00111 | | W Weight flow | /TAMPER/(+) | TAMPER W WDOTTS |
| DRY | | I Stage dry meight | /WTCALC/(24) | PRINTW I WDRY TAMPER I WDRY WTSCH M WDRY |
| DRYB | | O Stage dry meight — booster | /SUMVW /(4) | SUMDUT I WORYB |
| DR Y O | | O Stage dry weight -orbiter | /SUMVW /(17) | SUMOUT I WORYO |
| ENTAB | ***** | O Booster entry weight | | SUMDUT I WENTRB |

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| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORA
BLOCK | GE
LOC | SUBROUTINE
SUBR CODE | USAGE |
|-------------------|----------------|------|--|----------------|-----------|---|--|
| 314801 | STABUL | | | BLULA | LUL | 2084 CODE | T HIN |
| WENTRO | | 0 | Orbiter entry meight | /SUMVW /(| 331 | | WENTRO
WENTRO |
| WENTRY | | 1 | Entry seight | /EMS /(| 3) | PRHTSM 0 | MENTRY
MENTRY |
| WETURN | | 1 | Weight at return point | /EMS /(| 2) | PRWTSM 0 | WETURN
WETURN |
| WF UO X | | 1 | Weight of main and secondary propellant | /WTCALC/(| 46) | TAMPER I
WTSCH M | WFUOX
WFUOX
WFUOX
WFUOX |
| ₩F UO XB | | M | Propellant at. Less fpr -booster | /SUMVW /(| 3 > | | WF UO XB
WF UO XB |
| ₩F UO XO | | 1 | Propellant mt. Less for -orbiter | /TAMP /(| 3) | TAMPER I | ₩F UO XO
₩F UO XO
₩F UO XO |
| WFURES | | 1 | Fuel reserve | /WTCALC/(| 47) | STORE M
TAMPER I | WFURES
WFURES
WFURES
WFURES |
| ₩FU2 | | 1 | Weight of secondary fuel | /WTCALC/(| 34) | TAMPER I | WF U2
WF U2
WF U2 |
| WGR058 | | Ħ | Booster grass melght | /SUMVW /(| 5) | | WGROSB
WGROSB |
| ⊌GROSS | | I | Gross lift-off meight , | /CINPUT/(| 392) | PRWTSM I SOLVE M STORE M I TAMPER I WTSCH M I | WGROSS
WGROSS
WGROSS
WGROSS
WGROSS
WGROSS |
| WJET | | 1 | Jettison meight 1. Ignition to lift-off 2. Not used 3. Jettison during ascent 4. In-orbit jettison mt. 5. Pre-entry jettison mt. 6. Flyback jettison mt. | /WTCALC/(| 62) | PRWTSM M
STORE O
TAMPER I | MJET
MJET
MJET
MJET |
| HLAND | | 1 | Landing weight | /EMS /(| 4) | PRWT5M 0 4 | LAND |
| ⊌LANDB | | 0 | Landing weight - booster | /SUMVW /(| 35) | | LANDB |
| WLANDO | | 0 | Landing meight - orbiter | /SUMVW /(| 36) | | JLANDO
JLANDO |
| WOP | | 0 | Orbit maneuvering propellant meight | /SUMVW /(| 1) | | 40 P |
| #ORBIT | | ī | Weight in orbit | /EMS /(| 1) | | ORBIT |
| JORBTB
JORBTD | | | In-orbit weight - booster | /SUMVW /(| | | ORBTB
Dabto |
| | | _ | In-orbit seight - orbiter | /SUMVW /(| | TAMPER O W | ORBTO |
| 40 T HB | | | Misc. Weight - booster | /5UMYW /(| | TAMPER 0 W | IDTHB
IDTHB |
| 40THD | | _ | Misc. Weight - orbiter | /\$UMVW /(| | TAMPER D W | 0HT0 |
| OVERS | | 1 | Wing leading | /WTCALC/(| | TAMPER I | IOVERS
IOVERS
IOVERS |
| OVRSB | | 0 | Booster wing loading | /SUMVW /(| | | IO VRSB |
| IOVRSO | | 0 | Orbiter_wing_loading | /SUMVW /(| 28) | | OVRSO |

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| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAL
BLOCK | LOC | SUBROUTI
SUBR CO | |
|-------------------|----------------|--------|---|-----------------|------|--|----------------------------------|
| WOXRES | | I Ox | idizer reserve | /WTCALC/(| 89) | PRINTW I
STORE M
TAMPER I
WTSCH M | WOXRES
WOXRES
WOXRES |
| M0 X 2 | | 1 5e | condary oxidizer meight | /HTCALC/(| 84) | PRINTW 1
TAMPER 1
WTSCH M | W0 X2
W0 X2
W0 X2 |
| MPAYL | | I Pay | ylood meight | /HTCALC/(| 97) | PRINTW I
TAMPER I
WISCH M | MPAYL
MPAYL
MPAYL |
| WPAYLO | | ff Pay | yload meight | /SUMVW /(| 16) | SSSP 1
SUMOUT 1
TAMPER M | MPAYLD
MPAYLD
MPAYLD |
| WRTRNB | | 0 Ent | try seight- booster | /SUMVW /(| 32) | SUMOUT I
TAMPER O | WRTRNS
WRTRNS |
| WRTRNO | | 0 Ent | try meight- orbiter | /SUMVH /(| 31) | SUMOUT I | WATRNO
Watrno |
| TIANN | | Bur | smary meights 1. Ignition 2. Take-off 3.
rout 4. Initial orbiter 5. Initial entry 6.
itial flyback 7. Landing | /WTCALC/(| 122) | PRITVA I
PRWTSM I
STORE M
TAMPER I
WTSCH M | TIANU
TIANU
TIANU
TIANU |

TAMPER

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76.
17.
18.
19.
80.
81.
                                                                                                                                                            SIZING
SIZING
SIZING
          3
                                                                                                   PZ(5),
TLMG,
                                                                                                                                            SW(2G), SIZING
SIZING
SIZING
                                                                                                                         ٧a,
            C
                                                                                                     TOLMT,
ISIZE,
PRFLG,
IDVEL,
                                                                                                                                            SIZING
TWRATZ, SIZING
IPSMAX, SIZING
IPSMAX, SIZING
ISPB, SIZING
SIZING
SIZING
                                                                                                                        HPB,
TRAFLG,
IFASS,
ISPO,
  82
  83.
84.
85.
 86.
87.
88.
89.
90.
91.
                                                                                                   WEB
VSf6,
ITHBW
ISZO(19)
                                                                                                                  HÔ,
HÔO
LTNOH ,
                                                                                                                                                             UH
                                                                                                                                                             TAMPER
TAMPER
TAMPER
  91. C
93. 9
94. 95. 96. 97. 98. C
                        IFIRE = SE(2)
VV(1) = MGROSS
SV(7) = OMSAVE(1)
SV(4) = OMSAVE(4)
SV(6) = T034(3)
SQ(19,4) = MJET(5)
                                                                                                                                                             TAMPER
                                                                                                                                                             TAMPER
CKOUT
                                                                                                                                                             CKOUT
                                                                                                                                                             CKOUT
                           PROPULSION REFERENCE AREA (TOTAL)
                                                                                                                                                             CKONI
CKONI
CKONI
                        QP(11) = TB36 = SCB(218)
QP(12) = T036 = SCO(218)
 103.
 104.
105.
           £
                                                                                                                                                             TAMPER
 105. C
106. C
107. C
                                                                                                                                                             TAMPER
TAMPER
                                AERODYMAMIC REFERENCE AREAS
                        QP(6) = AERO REF AREA WITH SOLID MOTORS, BOOSTER, AND ORBITER
                                                                                                                                                             TAMPER
                                                                                                                                                             TAMPER
TAMPER
TAMPER
                        QP(7) = T845
QP(8) = T045
 108.
 109.
110. C
                        QP(10) = SCO(103)
QP(9) = VV(1) - WFUOX
                                                                                                                                                             CKOUT
                                                                                                                                                             CKOUT
TAMPER
TAMPER
TAMPER
                           ORBITER VACUUM THRUST AND ISP
 114.
           C
115.
116.
117.
118.
                                                                                                                                                             TAMPER
TAMPER
TAMPER
                        QP(2) = OTTOT + SE(8)
QP(4) = SE(7)
118. C
119. C
120. C
121.
122.
123. C
124. C
125. C
126.
127. C
                                                                                                                                                             TAMPER
TAMPER
TAMPER
                               BOOSTER WEIGHT FLOW
                        BWDDT1 = BTTDT + SE(9)/ SE(1)
SE(11) = 0.
                                                                                                                                                             TAMPER
                                                                                                                                                             TAMPER
TAMPER
TAMPER
                              TEST FOR PARALLEL BURN
                                                                                                                                                             TAMPER
TAMPER
TAMPER
                        60 TO (5,9) , IFIRE
                               SIMULTAMEOUS FIRE OF BOOSTER AND ORBITER
129.
130.
131.
                   5 CONTINUE
                                                                                                                                                             TAMPER
 129.
130. C
131. C
132. C
133.
134.
                                                                                                                                                             TAMPER
TAMPER
                               VACUUM THRUST AND ISP
                                                                                                                                                             TAMPER
                        QP(1) = DITOT+ SE(8) + BOTTOT+ SE(9)
OMDOT1 = DITOT + SE(8)/ SE(7)
MODIT1 = OMOOT1 + BOOT1
QP(3) = QP(1)/MDOTT1
                                                                                                                                                             TAMPER
TAMPER
TAMPER
136.
137.
138.
                                                                                                                                                             TAMPER
136.

137. C

138. C

140.

141.

142. C

143. C

145.

147.

146.

147.

148.
                                                                                                                                                             CKOUT
                               CALCULATE STAGE BURN TIMES
                                                                                                                                                             EKOUT
                                                                                                                                                             CKOUT
                                                                                                                                                             CKOUT
CKOUT
TAMPER
                        SQ(37,1) = (WFUOXB + SQ(37,5)) = QP(4)/QP(2)

SQ(37,2) = (WFUOXO + SQ(37,4)) = QP(1)/QP(3)
                                                                                                                                                             TAMPER
TAMPER
TAMPER
TAMPER
                                CHECK PROPELLANT CROSS FEED FLAG
                        IF(SE(1G).E0.0.) G0 TO 16
T2 = ( wFu0X - Bw00T1 + QP(19))/ Bw00T2
SE(11) = 0w00T1 + QP(19) + 0w00T2 + T2
QP(1G) = QP(1G) + SE(11)
QP(9) = QP(9) - SE(11)
                                                                                                                                                                           16-
                                                                                                                                                             TAMPER
TAMPER
                                                                                                                                                             TAMPER
```

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3

```
9 CONTINUE
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
TAMPER
TAMPER
 150.
 151
152.
153.
154
155.
                                 CONTINUE
SEQUENTIAL FIRING OF BOOSTER AND ORBITER
TANDEM FIRING OF BOOSTER AND ORBITER
THRUST AND ISP
                 0000
                                QP(1) = BTTOT + SE(9)
QP(3) = QP(1)/BWDOT1
                                                                                                                                                                                                           TAMPER
TAMPER
 157.
158.
159.
160.
161.
162.
163.
164.
165.
                         TAMPER
                                                                                                                                                                                                           CKOUT
TAMPER
TAMPER
                 CCC
                                          CHECK SOLID MOTOR OPTION FLAG
                                                                                                                                                                                                           TAMPER
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
                                IF(SQ(20,1).LE.O.) GO TO 18
VV(1) = VV(1) + SQ(21,5)
SV(13) = (QP(1) + TB27(2)/QP(3) + SQ(21,4))/VV(1)
TZ = (QP(1) + SQ(22,4))/(BWDOT1 + SQ(21,3)/SQ(21,2))
                                                                                                                                                                                                           TAMPER
            CKOUT
 167.
                                                                                                                                                                                                          TAMPER
 168.
169.
170.
171.
172.
173.
174.
175.
176.
177.
178.
181.
181.
                                                                                                                                                                                                           TAMPER
TAMPER
                                                                                                                                                                                                          05
05
                                                                                                                                                                                                          CKOUT
                                                                                                                                                                                                           TAMPER
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
                                ENTRY ORBSUM
ORBITER SUMMARY WEIGHTS
                                                                                                                                                                                                          TAMPER
TAMPER
                               TAMPER

SO(37,4) = WEURES + WOXRES

MOP=WFU2(1)+WDX2(1)

MAPER

MAPFU2(1)+WDX2(1)

MAPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

MORNO = WORBIT

MORNO = WORBIT

MORNO = WORBIT

MAPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

MARTHO = WETURN

MENTRO = WETURN

MENTRO = WETURN

MENTRO = WENTRY

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER

TAMPER
 183.
184.
185.
186.
187.
188.
189.
190.
191.
192.
193.
194.
195.
196.
197.
                                                                                                                                                                                                          TAMPER
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
                                ORBITER SUMMARY VOLUMES
                                VFUTKO = VFUTK
VOXTKO = VOXTK
VCARO = VCARGO
VOTHO = VBODY - VCARGO - VOXTK - VFUTK
VBODYO = VBODY
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
TAMPER
 200.
201.
202.
203.
                C
C
C
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
                                  ORBITER SUMMARY GEOMETRY
                                LBODYO = LBODY
SBODYO = SBODY
SPLANO = SPLAN
MOYRSO = MOYERS
                                                                                                                                                                                                           TAMPER
 204.
205.
206.
207.
208.
209.
210.
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
                                RETURN
                C
                                ENTRY BOOSUM
BOOSTER SUMMARY WEIGHTS
                C
                                                                                                                                                                                                           TAMPER
210. C
211. C
212
213
214.
215.
216.
217.
218.
219.
220.
221.
221.
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
                               SO(37,5) = WFURES + MOXRES
WABFUB = ABS(WABFU)
WFUDXB = WFUDX
WCONTB = WCONT
WDRYB = WDRY
WGROSB = WBOO
WOTHB = WGROSB - WFUOX - WA
WOTHB = WGROSB - WFUOX - WA
WORBTB = WORBIT
WATRNB = WETURN
WENTRB = WENTRY
WLANDB = WLAND
                                                                                                                                                                                                           TAMPER
                                                                                                                                                                                                          TAMPER
                                                                                                                                                                                                           TAMPER
                                                                                                                                                                                                          TAMPER
TAMPER
TAMPER
                                                                      - WFUOX - WABFUB - WORY - SQ(37,5) - WCONT
                                                                                                                                                                                                          TAMPER
TAMPER
                                                                                                                                                                                                          TAMPER
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224. C BOOSTER SUMMARY VOLUMES TAMPER
225. C
226. VFUTKB = VFUTK TAMPER
227. VOXTKB = VOXTK TAMPER
228. VOTHB = VBODY - VFUTK - VOXTK TAMPER
229. VABFUB = VOXTK2 + VFUTK2 TAMPER
230. VBODYB = VBODY TAMPER
231. C
232. C BOOSTER SUMMARY GEOMETRY TAMPER
233. C TAMPER
234. LBODYB = LBODY TAMPER
235. SBODYB = SBODY TAMPER
236. SPLANB = SPLAN TAMPER
237. WOVERS = WOVERS TAMPER
238. RETURN
239. END
```

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SUBRØUT I NE TBL2D

| EDHTRAN
Symbol | MAIH
Symhol | CODE | DESCRIPTION | SIGRAGE SUBHOUTINE USAGE
BLULK LOC SUBH LOOK VAR |
|-------------------|----------------|------|--|---|
| 18120 | | E | Two dimensional table look-up surboutine | /T8L2D /(\$) RANGE S T8L2D
T8L2D E T8L2D |

| | 1. | | SUBROUTINE TBL20(X,Y,XTBL,YTBL,ZTBL,Z) | T8L20 | l | |
|-----|------------|--------|--|----------------|---------|-------------|
| | 2. | C
C | 2 DIMENSIONAL TABLE LOOK-UP | TBL2D
TBL2D | ł | |
| | 4. | č | DIMENSION XTBL(7), YTBL(7), ZTBL(7,7) | TBL2D
TBL2D | | |
| | 6. | | K = 0
DO 1 11=2,7 | T8L20
T8L2D | ł | |
| Г | 1 B. | | 1=11 | TBL2D | ١ | |
| L | 9. | | 1F(X-XTBL(1)) 3,2,1
1 CONTINUE | TBL2D | 1 2° | ٦,٦ |
| | 11. | | GO TO 3 | TBL20 | L | ∮ 3⊣ |
| | 12.
13. | | 2 K = 1
GD TO 4 | TBL20
TBL2D | 4- | - 1 |
| | 14 | | 3 SCAL1 = (X-XTBL(I-1))/(XTBL(I)-XTBL(I-:)) | T&L2D | | |
| Г | 15.
16. | | 4 DO 5 JJ=2,7
J=JJ | TBL20
TBL2D | | |
| Ħ | 17. | | IF(Y-YTBL(J)) 7,6,5 | TBL20 | 506 | ריר |
| ٦ | 18.
19. | | 5 CONTINUE
GO TO 7 | TBL20
TBL20 | | 1,- |
| | 20. | | 6 SCAL2 = 1. | TBL2D | | - |
| | 21. | | GO TO 8 7 SCAL2 = (Y-YTBL(J-1))/(YTBL(J)-YTBL(J-1)) | TBL2D
TBL2D | <u></u> | |
| | 23. | | 8 JF(K-1) 9,10,9 | TBL20 | 9-11 | 7 |
| 1 | 24.
25. | | 9 | TBL20
TBL2D | Г. | - |
| | 26. | | Z = ZIBE(1-1,3) + SCHLI+(ZIBE(1,3) - ZIBE(1-1,3)) Z = ZI + SCHL2+(ZZ - ZI) | TBL20
TBL20 | İ | ı |
| | 27. | 1 | RETURN 0 Z = ZTBL(1,J-1) + SCAL2*(ZTBL(1,J) - ZTBL(1,J-1)) | TBL2D | | _1 |
| | 29.
30. | C | RETURN | TBL2D
TBL2D | | |
| - 1 | 31. | | END | | ł | |
| - 1 | | | 5.00 | TBL2D | | |
| | | | | 18120 | | |
| | | | | 18120 | | |
| | | | ` . | 18120 | | |
| | - | | | 181,20 | | |
| | - | | | IBLZU | | |
| | - | | | 151.20 | | |
| | - | | | IBLZU | | |
| | - | | | IBLZU | | |
| | - | | | IBLZU | | |
| | - | | | 151.20 | | |
| | - | | | 151.20 | | |
| | - | | | 151.20 | | |
| | - | | | 151.20 | | |
| | - | | | 151.20 | | |
| | - | | | IBLZU | | |
| | - | | | 15120 | | |
| | | | | IBLZU | | |
| | | | | IBLZU | | |
| | | | | IBLZU | | |
| | | | | IBLZU | | |
| | | | | IBLZU | | |

SUBRØUT I NE THRUP

| FORTHAN
SYMBOL | MATH
Symbol | CODE | DESCRIPTION | | STOR
BLOCK | RAJE
LOC | SUBROUTING
SUBR CODE | |
|-------------------|----------------|-------------|---|------------|---------------|-------------|--|--|
| LOCI | | 5
1
c | t 50 word array that corresponds to tables 1 to 0. Each entry is an integer that points to 1 nitlal value of the independent variable of to presponding table. A zero entry indicates to 1 input. | the
the | /TABLE | /(1) | SPLICO M
SPLICO M
SPLIZ I
SPLIZ I
SPLYNE I
SPLYNE I
THRUP I
THRUP O | Y
FOCI
X
FOCI
FOCI
FOCI |
| x | | 5
1
c | is 50 word array that corresponds to tables 1 of 0. Each entry is an integer that points to on itial value of the independent variable of orresponding table. A zero entry indicates of input. | the
the | /TABLE / | /(1) | SPLICO M
SPLICO M
SPLIZ I
SPLIZ I
SPLYNE I
SPLYNE I
SPLYNE I
THRUP I
THRUP O | X
FOCI
X
FOCI
TOCI
TOCI |
| Y | | 5
I | 50 word array that corresponds to tables 1 to 0. Each entry is an integer that indicates to ast interval in which interpolation of the orresponding table occured. | | /TABLE A | /(701) | SPLICO O
SPLICO M
SPLIZ M
SPLIZ I
SPLYNE M
SPLYNE I
THRUP O | A
FOCT
A
FOCT
TOCT |
| Z | | 5
I | 50 mord array that corresponds to tables 1 t
0. Each entry is an integer that points to t
ast value of the independent variable of the
orresponding table. | | /TABLE / | ((1401) | SPLIZ I
SPLYNE I
SPLYNE I | LOCF
Z
LOCF
Z
LOCF
Z |

1207

```
1. SUBROUTINE THRUP(ITAB, F1, T2, F2)

2. C

3. C

THIS SUBROUTINE SETS UP THE LINEAR THRUST

4. C

TABLE NUMBERED ITAB. THE TABLE ENTRIES

THRUP

5. C

F1, T2 AND F2 ARE DETERMINED BY THE SIZING

THRUP

6. C

MOULE FOR USE IN THE TRAJECTORY MODULE.

THRUP

7. DIMENSION LOCI(1)

8. EQUIVALENCE (LOCI, X)

TO COMMON/TABLE/ X (760), Y (700), Z (700)

THRUP

10. C

FIND THE FIRST ENTRY OF ITAB.

THRUP

11. C

11 = LOCI(ITAB)

THRUP

12. II = LOCI(ITAB)

THRUP

13. C

SET THE INITIAL TIME OF ITAB TO ZERO AND

THRUP

16. C

X(11) = 0.

X(11) = 0.

X(11) = 0.

X(11) = 0.

THRUP

20. C

AND FINAL TIME OF ITAB AND THE IMITIAL

THRUP

21. C

STORE THE FINAL TIME OF ITAB AND THE IMITIAL

THRUP

22. C

AND FINAL VALUES OF THRUST.

THRUP

24. X(11 + 1) = T2

THRUP

26. Y(11) = F1

THRUP

27. RETURN

THRUP

THRUP

THRUP

THRUP

28. END
```

SUBRØUT I NE THRUST



| ORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | # STORAGE
BLOCK LOC | SUBROUTINE USAG
SUBR CODE VAR |
|------------------|------------------|--|---|--|
| FSLB | | M Booster sea level thrust (lb) | /TRUST /(6 |) THRUST M FSLB |
| FSLL0 | | M Sea level lift-off thrust (1b) | /TRUST /(1 |) THRUST M FSLLO |
| FSL0 | | M Orbiter sea level thrust (1b) | /TRUST /1 2 |) THRUST A FSLD |
| FSLS | | M Solid motor sea level thrust (16) | /TRUST /(8 |) THRUST M FSLS |
| FUNIT | | W Orbiter thrust per engine vac. (16) | /THRUST/(+ |) THRUST W FUNIT |
| FVACB | | M Booster vacuum thrust (lb) | /TRUST /(5 |) THRUST M FVACB
WTSCH M FVACB |
| FVACLO | | M Total vacuum lift-off thrust (lb) | /TRUST /(3 |) THRUST M FVACLE |
| FVACS | | M Solid motor total vacuum thrust (ib) | /TRUST /(4 |) THRUST M FVACS |
| AT | | 1 Curve number -thrust table | /ARCDAT/(25 |) FXDAT I MT
PROPB I MT
PROPIN I MT
THRUST I MT |
| SCB , | | M Working name for input c-array booster scaling coefficients | /ORBINY/(144 | FLYBKP M SCB
STORE M SCB
SUMOUT I SCB
TAMPER I SCB
THRUST M SCB
VEHDF I SCB
WTVOL M SCB |
| SE | | I Array of synthesis iteration propulsion parameto | ers /51Z1NG/(259 | PRITMA I SE PRITMA I SE SIZEMR I SE SIZEMR I SE SUMOUT I SE TAMPER M SE THRUST I SE WEHDF M SE WISCH I SE WITVOL M SE |
| 5 Q | | M A synthesis data array (37,5) that contains the flyback data and some injection quantities | | ENVERM M SQ FLYBRP M SQ ISPRAT I SQ PDBC I SQ PRITVA I SQ RANGE M SQ SIZER M SQ SIZER M SQ SIZER M SQ SIZIM M SQ SIZIM M SQ SIZIM M SQ SIZIM M SQ SIZIM M SQ SIAUDI M SQ TAMPAR Q SQ TAMPAR Q SQ TAMPAR M SQ |
| REF | S _{ref} | I Aerodynamic reference area (F | : _T 2 ₎ /ARCDAT/(1 | BNTG |
| 836 | | I Stored booster value of nemgs | /ORBINY/(60 | STORE # TB36
SUMOUT I TB36
TAMPER I TB36
THRUST I TB36
WIVOL I TB36 |
| HRUST | | -E Subroutine-to determine booster, orbiter, and | - /THRUST/(s -) | DATAIN S THRUST |

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| FORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAG
Block | E
LOC | SUBROU
SUBR | | E VAR |
|-------------------|----------------|----------|------------------------|-----------------|----------|---------------------------|---|----------------------|
| T036 | | I Stored | orbiter value of nengs | /ORBINX/(| 60) | STORE
SUMOUT
TAMPER | I | T036
T036
T036 |
| | | | | | | THRUST
MT VOL | | T036 |

```
THRUST
                                                          SUBROUTINE THRUST
     1.
2.
3.
4.
5.
6.
7.
8.
                                                                                                                                                                                                                                                                                                                                                                                                                    THRUST
THRUST
THRUST
                       CCCC
                                                                               SUBROUTINE TO CALCULATE BOOSTER, ORBITER, AND VEHICLE THRUST
                                                 THRUST
                                                                                                                                                                                                                                                                                                                                                                                                                     SIZING
                                                                                                                                                                                                                                                                                                                                                                                                                  SIZING
SIZING
SIZING
SIZING
SIZING
SIZING
SIZING
                          C
10.
11.
12.
                           C
13.
14.
15.
16.
17.
18.
19.
20.
22.
23.
25.
                                                                                                                                                                                                                                                                                                                                                                                                                   SIZING
SIZING
SIZING
                                                                                                                                                                                                                                                                                                                                                                                                                     SIZING
                                                                                                                                                                                                                                                                                                                                                                                                                    UH
Drbinx
                                                                                                                                                                                                                                                                                                                                                                                                                 CROUT

ORBINX

ORBINX

ORBINX

ORBINX

ORBINX

ORBINX
26
21.
                                                                                                                                                                                                                                                                                                                                                                                                                     CKOUT
                                             / TOT2, TOT3, TOT4, TOT5, TOT6, TOT7, TOT8, TOT7, TO88, TO69, TO70, TO71, 8TO84

DIMENSION SKB(30), SCB(300), TB4(6), TB20(10), TB27(6), TB34(6), 1 TB48(10), TB49(10), TB50(10), TB57(6), BMSAVE(10)

COMMON/ORBINY/

1 TB1, TB2, TB3, TB4, TB5, TB6, TB7, TB8, TB9, TB10, TB11, TB12, TB13, TB14, 2 TB15, TB16, TB17, TB18, TB19, TB20, TB21, IB22, IB23, IB24, IB25, IB26, TB27, 3 1B28, IB29, IB30, IB31, IB32, TB33, TB34, TB35, TB36, IB37, TB38, TB39, TB40, 4 TB41, TB42, TB43, TB44, TB45, TB46, TB47, TB48, TB49, TB50, TB51, TB52, TB53, 5 TB54, TB55, TB56, TB57, SKB, SCB, BMSAVE

6 TB59, TB60, TB61, TB62, TB64, TB64, TB47, TB48, TB49, TB69, TB69, TB70, TB71, IB72, TB73, TB74, TB75, TB76, TB77, TB78, TB79, TB80, TB84, TB82, TB83, TB84, TB49, TB64, TB77, TB78, TB79, TB80, TB81, TB82, TB64, TB79, TB80, TB81, TB82, TB84, TB79, TB80, TB81, TB82, TB84, TB79, TB80, TB81, TB82, TB84, TB79, TB80, TB81, TB82, TB84, TB82, TB84, TB82, TB84, TB82, TB84, TB82, TB84, TB82, TB84, TB82, TB84, TB82, TB82, TB84, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82, TB82
                                                                                                                                                                                                                                                                                                                                                                                                                    UH
UH
28.
29.
30.
31.
32.
33.
35.
36.
                                                                                                                                                                                                                                                                                                                                                                                                                    ORBINY
                                                                                                                                                                                                                                                                                                                                                                                                                   CKOUT
ORBINY
ORBINY
ORBINY
                                                                                                                                                                                                                                                                                                                                                                                                                    ORBINY
                                                                                                                                                                                                                                                                                                                                                                                                                     ŪН
3344944444445555555555555
                                                                                                                                                                                                                                                                                                                                                                                                                    CKOUT
                                                                                                                                                                                                                                                                                                                                                                                                                    THRUST
THRUST
ARCDAT
                                                       COMMON/ARCDAT/

SAEF F.J. XI

IATM ,IMODE ,JR

*IATM ,IMODE ,JR

*ALMAX ,HDMAX ,GR

*MT ,MISP ,MI

*MOD ,XGR ,ZC

*DREF ,MCND ,R

*FRATE ,ARCD(9)

**DIMENSIOM ARCDA(40)

**EQUIVALENCECSREF,ARCDA)

**FTABB = 0.
                                                                                                                                                                                                                                                                                       DINC
QMAX
PHMAX
MAEF
MWDA
ZE
REMAX
                                                                                                                                                                                                                                                                                                                                                DTPI
GMAX
MAEA
MAEG
MUDB
XT
                                                                                                                                                                                                                                TMULT
JPRO
ALFMAX
MAEE
MZCG
                                                                                                                                                                                                                                                                                                                                                                                                                    ARCDAT
                                                                                                                                                                     ,XISP
,JAER
,GMDOT
,MAED
,MXCG
,ZCGR
,RHOB
                                                                                                                                                                                                                                                                                                                                                                                                                 ARCDAT
ARCDAT
ARCDAT
                                                     -MAEB
                                                                                                                                                                                                                                                                                                                                                                                                                  ARCDAT
ARCDAT
ARCDAT
RETAP
                                                     -MT
                                                                                                                                                                                                                                  , XE
, OMULT
                                                      -DREF
                                                                                                                                                                                                                                                                                                                                                                                                                    ARCDAT
ARCDAT
THRUST
                                                         FTABB = 0.
FTABB = 0.
FTABO = 0.
CALL READMS (9,SREF,40,1)
ITAB=MT
IF (SW(17).EQ.0..OR.SQ(20,1).LE.0..OR.SE(2).EQ.1.) GO TO 6
IF (MT GT.0.AND.SQ(20,1).LE 0.) CALL SPLIZ(MT,0,FTABB,DUM)
                                                                                                                                                                                                                                                                                                                                                                                                                    THRUST
CKOUT
CKOUT
                                                                                                                                                                                                                                                                                                                                                                                                                     CKOUT
 61.
                                                                                                                                                                                                                                                                                                                                                                                                                     CKOUT
62.
                                                6 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                     CKOUT
                                                         CONTINUE

10RBI = SQ(1,3)

CALL READMS (9, SREF, 40, 10RBI)

IF(MT.LE.O) GO TO 5

CALL SPLIZ(MT,O,FTABO,DUM)
63.
64.
65.
                                                                                                                                                                                                                                                                                                                                                                                                                     CKOUT
                                                                                                                                                                                                                                                                                                                                                                                                                    CKOUT
                                                                                                                                                                                                                                                                                                                                                                                                                    CKOUT
                                                5 CONTINUE

IF( FTABB.NE.O ) SCB(129) = FTABB/TB36

IF( FTABO .NE. O ) SCO(129) = FTABD/T036
                                                                                                                                                                                                                                                                                                                                                                                                                    CKOUT
UH
UH
61.
68.
69
70.
71.
72.
73.
                                                          IF( FTABO .NE. 0 ) SIF(MT.GT.0) GO TO 1
                                                                                                                                                                                                                                                                                                                                                                                                                    UG
THRUST
THRUST
THRUST
                           CCC
                                                                              COMMON ENGINES USED
                                                          IF(SE(3).GE.1.) 60 TO 1
```

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```
0
                                                                                                                                                         THRUST
                               CALCULATE ORBITER UNIT THRUST FROM BOOSTER THRUST
  16.
77.
18.
79.
80.
81.
                                                                                                                                                         THRUST
THRUST
CKOUT
THRUST
                                                                                                                                                         THRUST
                                CALCULATE ORBITER UNIT THRUST
                                                                                                                                                         THRUST
THRUST
  83.
84.
                    1 FJNIT = SCO(129)
                                                                                                                                                         CKOUT
THRUST
            CCC
                               CALCULATE BOOSTER AND ORBITER THRUST
   86
                                                                                                                                                         THRUST
                   2 FVACO = FUNIT* T036 *SE(8)

FSLO = FVACO - SCO(218) *T036 *2116.217

FVACB = SCB(129) * T836 * SE(9)

FSLB = FVACB - SCB(1218) * T836 *2116.217
  87.
                                                                                                                                                         UH
  88.
89.
                                                                                                                                                         HU
          C
C
C
                                                                                                                                                         THRUST
THRUST
THRUST
91.
92.
93.
94.
95.
97.
98.
99.
100.
101.
102.
103.
                               CHECK PARALLEL BURN FLAG
                       1F(1TAB.GT.O.AND.SQ(20,1).LE.O.) 60 TO 3 IF(SE(2).GE.2.) 60 TO 3
                                                                                                                                                         CKOUT
                                                                                                                                                         THRUST
THRUST
THRUST
           C
C
C
                               ADD THRUST LEVELS FOR LIFT-OFF THRUST
                                                                                                                                                         THRUST
                       FYACLO = FYACO + FYACB
FSLLO = FSLO + FSLB
GO TO 4
                                                                                                                                                         THRUST
THRUST
THRUST
                                                                                                                                                         THRUST
                               DETERMINE LIFTOFF THRUST
                                                                                                                                                         THRUST
                   3 FVACLO = FVACB
FSLLO = FSLB
105.
                                                                                                                                                         THRUST
 106.
107.
108.
                                                                                                                                                         THRUST
THRUST
THRUST
                               CHECK SOLID MOTOR FLAG
109.
                                                                                                                                                         THRUST
110.
                    9 IF(SQ(20,1).LE.O.) RETURM
                                                                                                                                                        CKOUT
           000
111.
112.
113.
114.
115.
116.
117.
118.
119.
120.
121.
                               DETERMINE SOLID MOTOR THRUST AND NEW LIFT-OFF THRUST
                                                                                                                                                        THRUST
THRUST
THRUST
                       FVACS = SQ(20,2) * SQ(20,1)

FSLS = FVACS - SQ(21,1)*SQ(20,1)*2116.217

FVACL0 = FVACL0 + FVACS

FSLL0 = FSLS

F1 = FVAC0

12 = SQ(21,2)

F2 = F1 - 72* SQ(20,3)

CALL THRUP(ITAB,F1,T2,F2)
                                                                                                                                                        THRUST
THRUST
THRUST
                                                                                                                                                         CKOUT
                                                                                                                                                        CKOUT
CKOUT
CKOUT
CKOUT
CKOUT
121.
122. C
123. C
124. C
125.
126.
127.
128.
129.
130.
131. C
132. C
                               ESTABLISH QUANITIES FOR TWO ENGINE SIMULATION
                       IF(SQ(30,1).ME.O.) GO TO 10
SQ(31,1) = FVACB
SQ(31,2) = FVACS
SQ(31,3) = SQ(20,4)/SE(1)
SQ(31,3) = SE(1)
RETURM
                                                                                                                                                         CKOUT
                                                                                                                                                                       10-
                                                                                                                                                         CKOUT
                                                                                                                                                         CKOUT
JULY28
CKOUT
                               EXTERNAL TANK OPTION USED
                                                                                                                                                         CKOUT
                                                                                                                                                         CKOUT
134.
135.
136.
137.
138.
                  10 CONTINUE

$0(31,1) = FVACO

$0(31,2) = FVACS

$0(31,3) = $0(20,4)/$E(7)

$0(31,4) = $E(7)
                                                                                                                                                        CKOUT
CKOUT
CKOUT
CKOUT
                                                                                                                                                         THRUST
140.
141.
142.
143.
                             RETURN TO CALLING PROGRAM
                999 RETURN
                                                                                                                                                         THRUST
                                                                                                                                                         THRUST
```

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SUBRØUT I NE VEHDF



| ORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAG
BLOCK | LOC | SUBROU
SUBR | COL | E USAG |
|------------------|----------------|------|---|-----------------|------|--|---------------------------------|--|
| | | | | | | | | |
| • | | n | Booster sub-somic 1/d | /DATA21/(| 1) | SSSP
VEHDF
VEHDF | 0 | A
A
ALD |
| LO | | i | Booster sub-sonic 1/6 | /DATA2X/(| 1) | SSSP
VEHDF
VEHDF | D
M
I | A
ALD |
| LD1 | | 1 | Booster flyback cruise velocity | /DATAZI/(| 52) | VEHDF | 1 | ALD1 |
| LD2 | | ī | Fing for crossfeed of propellants from booster tanks to orbiter engines at lift-off if fire =1 | /DATA2X/(| 53) | VEHDF | 1 | ALD2 |
| LO3 | | 1 | Datu/ print flag | /DATA2X/(| 54) | VEHDF | I | ALD3 |
| ıs | | 1 | Number of allowable synthesis iterat ~ions (max = 6) | /DATA2X/(| ••• | VEHDF | 1 | AS |
| ECO | | 1 | Booster cut-off erc | /S121NG/(| | SIZE | I | BECO |
| S | | I | Booster thrust multiplier for ascent | /DATA2X/(| | VEHDF | 1 | BS |
| STG | | ı | Booster staging arc | /SIZ146/(| | SIZE | I | BST6
BST6 |
| В | | 1 | Orbiter mass ratio tolerance input | /DATA2%/(| | VEHDF | 1 | CB |
| LA6 | | 1 | Specific fuel consumption of booster air breathers | /DATA2X/(| | VEHDF | 1 | CFAR |
| ATA2 | | 1 | Mamelist input block | /VEHDF /(+ | - | VEHDF | I | DATAS |
| RNG | | I | Output flag for sizing data | /DATA2X/(| | VEHDF | ı | DRNG |
| BPAR | | 1 | Estimate of slope for booster cruise adjustment if moreq 70 or mporeq 70 | /DATA2X/(| | VEHOF | ı | FBPAF |
| IPSMX | | ī | Masimum number of iterations | /5121NG/(| 292) | SIZE
SSSP
VEHDF
VEHDF | I
I
O | IPSMA
IPSMA
HIPSM
IPSMA |
| D | | | A four word array containing the basic deck, reference run, case and part case numbers in that order. | /SLOBAL/(| 21) | BLICO
FRENCH
GEINP
PADSI
PRINT
SDINP
TOPM
VEHDF | 1
1
0
1
1
1
1 | 10
10
10
10
10
10 |
| DAEFO | | I | Total ideal velocity estimate to parking orbit insertion | /DATA2X/(| 3) | VEHDF | 1 | IDVEL |
| PSMAX | | 0 | Assimus number of Iterations | /SIZING/(| 292) | SIZE
SSSP
VEHDF
VEHDF | I
I
O | IPSMA
IPSMA
HIPSM
IPSMA |
| XFOB | | I | Booster effective isp estimating parameter | /DATA2X/(| 26) | VEHOF | 1 | NXFOB |
| 188 | | ı | Orbiter ignition arc | /SIZING/(| 316) | REU3
S12E
VEHDF | I
I
I | ORBI
ORBI
ORBI |
| ERISP | | 1 | Orbiter sea level specific lapuise | /DAT 42%/(| A) | VEHDE | i | PERIS |
| 1 | | • | Ratio of booster to orbiter engine thrust (vac) | /DATA2X/(| | VEHDE | 1 | RT |
| ,
1 | | 1 | Desired value of 1.0. T/s | /DATA21/(| | VEHDE | i | RI |
| 3 | | ; | Maximum number of iterations to obtain twio | /DATA2X/(| | VEHDE | i | R3 |
| 8 | | ī | Working name for input c-array booster scaling coefficients | /ORBINY/C | 144) | FLYBKP
STORE
SUMOUT
TAMPER
THRUST
VEHDF | | SCB
SCB
SCB
SCB
SCB
SCB |

| E Array of synthesis iteration propulsion parameters . | /\$1Z1NG/(| 259) | 5. VA/A | | |
|---|------------|------|---|---|---|
| | | | PRITVA
SIZEMR
SUMOUT
TAMPER
THRUST
VEHDF
WTSCH
WTVOL | I | SE
SE
SE
SE
SE
SE
SE
SE |
| C1 I Output print flag | /DATA2X/(| 49) | VEHDF | 1 | SFC1 |
| C2 I Ascent burn sequence flag l= simultaneous stage
burn 2= sequential stage burn | /DATA2X/(| 50) | VEHDF | I | SFC2 |
| CO I Solid engine cut-off erc | /SIZIMG/(| 326) | VEHDF | I | SOCO |
| LID 1 Number of copies of summary sheet to be output | /DATA2X/(| 31) | VEHDF | I | SOLID |
| SP I Solid engine drop arc | /S121MG/(| 327) | VEHDF | I | SOSP |
| A synthesis data array (37,5) that contains the flyback data and some injection quantities . | /S121NG/(| 74) | RANGE
REU3
SIZE
SIZEMR
SIZIN
STANDUT
TAMPAR
TAMPAR
THRUST
TRTOSZ | MITIMODAMENOMA | 50
50
50
50
50
50
50
50
50
50
50
50
50
5 |
| A synthesis array (28) containing staging parameters and misc flags | /S121NG/(| 46) | TTER8 RANGE SIZEMR SIZIN SSSP SUMOUT TAMPAR TAMPER TATOSZ | 1
1
1
1
1
1
1
0
8 | 25555555555555555555555555555555555555 |
| 27 A Stored booster value of isp(i) | /ORBINY/(| | SUMOUT
TAMPER
VEHDF | I
M
I
I | T827
T827
T827
T827
T827
T827
T821 |
| 34 I Stored booster value of mr(i) | /ORBINY/(| | TERB
SSSP
STORE
SUMOUT
TAMPER
VEHOF | 0
M
H
I
I
I | T834
T834
T834
T834
T834
T834
T834
T834 |
| CTRB I Booster bec. Isp | /DATA2X/(| 15) | VEHDF | 1 | TFCTRE |
| A Stored arbiter value of isp(1) | /ORBINX/(| | SIZEMR
SSSP
STORE | 1 | T027
T027
T027 |

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| FORTRAN | MATH | CODE | DESCRIPTION | STORAG | | SUBROU | TIN | E USAGE |
|---------|--------|------|--|-------------|------|--|-------------------------------------|---|
| SYMBOL | SYMBOL | | DESCRIPTION | BLOCK | LOC | SUBR | COD | E VAR |
| 1034 | | C | Stored orbiter value of mr(1) | /ORBINK/(| 53) | ITERO
SSSP
STORE
TAMPER
VEHDF
WTVOL | 8 0 M I O M | T034
T034
T034
T034
T034
T034 |
| TRAFLG | | 0 | Traffic control flag O. Sizing loop not converged 1. Sizing loop converged 2. Error in sizing loop next case | /51Z1NG/(| 264) | FRENCH
ITER8
PADS1
SIZE
SSSP
VEHDF | 0 0 1 6 0 0 | TRAFLG
TRAFLG
TRAFLG
TRAFLG
TRAFLG |
| TRATIO | | 1 | Orbiter vec. 1sp | /DATA2X/(| 19) | VEHDF | 1 | TRATIO |
| 1580 | | 3 | Orbiter thrust multiplier for ascent | /DATA2X/(| 37) | VEHDF | 1 | TSBO |
| VEHDF | | £ | Subroutine to call and initialize synthesis data | /VEHOF /(S |) | DATAIN
VEHOF | S
E | VEHDF
VEHDF |
| MFLYX | | I | Tolerance on twio iteration | /DATA2X/(| 45) | VEHDF | 1 | WFLYX |
| UNO6. | | 0 | File of all output data | /.UN06./(\$ | | MOMJOUT 22 PRINT VALUE PRINT VALUE PRINT VALUE PRINT VALUE PROPHISM PROPHIS | 00000000000000000000000000000000000 | - UNO6 - |



```
SUBROUTINE VENOF
VENDE
                                                                                                    SUBROUTINE READS SYNTHESIS DATA AND SETS MORKING VARIABLES

ADJUSTS ORBITER MASS RATIO

SOLID MOTOR OPTION WTS AND THRUST
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             VEHOE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              VEHBF
VEHBF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               VEHBE
                                                                                                   ARRAY B(57) IS USED TO OBTAIN THE SYNTHESIS DATA FROM THE PADS PROGRAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WE HOE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              VEHDF
VEHDF
                                                                    DIMENSION A(57)
LOGICAL MEGO
EQUIVALENCE(ALD,A(1))
A(1P) MAX MIPSMX)
AEAL MXFÓB
REAL IVACO, IVA
COMMON/DATAZX/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CKOUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CKOUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              UH
DATAZX
                                                               REAL NAFÓB
REAL IVACO, IVACB, ISLO, ISLB, IOVELO
COMMON/DATA2X/
**ALD, FBPAR 10VELO ISLB, ISLO, IVACB, IVACO, PERISP, QMXX,
1 QMXS, SFC, SLVOUT, CÓPIES, SYNIT, FECTRB, TECTRD, TOLMU, TOLTM,
2 TRATIO, TMLO, THLOI, WTOUT, FIRE, BOOTM, VCRUSE
3, NAFOB, PARNIX, FSEC, CLVG DRNG
4, SOLID, AS, BS, SISP, SINEAT, SAE, TSBO, FLVBCK
5, WDPDREO, WDREÓ, GMRÉQ
6, FBFUEL, CA, CB, WFLVX, RT, R1, R3, SFC1, SFC2, SFC3, ALD1, ALD2, ALD3, VFLV1,
7 VFLV2, VFLV3
**TMOX(2) PNDX(10), BLOW(10), BUPP(10), STEP(11), PAYX
ÉQUIVALENCE (RVAR TWOX(2))
REAL MUB, MUO, ISPB, ISPD, IDVEL, NMB, NO
COMMON / SIZINB/
PHASE II SIZING PARAMERERS
**IZ, VV(3), QP(14), ERDR, PZ(5), VQ, SW(20),
**SV(28), SG(31,5), SE(11), TLAT, TLNG,
PHASE II SIZING PARAMERERS
**BBO, WLOO, DWEB, DWEO, TOLMT, WPB, TWRATO,
**BK1, BK2, BK3, BK4, ISIZE, TRAFLG, TWRATO,
**OK1, OK2, OK3, OK4, PARLG, IPASS, IPSMAX,
**AEXIT, TVACO, NO, WFD, IDVEL, ISPO, ISPB,
**PL, TVACB, NNB, MEO, WEB, MO, WLO,
**PL, TVACB, NNB, MEO, WEB, MO, WLO,
**PL, TVACB, NNB, MEO, WEB, MO, WLO,
**PL, TVACB, NNB, MEO, WEB, MO, WLO,
**PL, TVACB, NNB, MUD, VSTG, WPO,
**PL, TVACB, NNB, MUD, VSTG, WPO,
**PL, TVACB, NNB, MUD, VSTG, WPO,
**PL, TVACB, NNB, MUD, VSTG, WPO,
**PL, TVACB, NNB, MUD, VSTG, WPO,
**PL, TVACB, NNB, MUD, VSTG, MPO,
**PL, TVACB, NNB, MUD, VSTG, MPO,
**PL, TVACB, NNB, MUD, VSTG, MPO,
**PL, TVACB, NNB, MUD, VSTG, MPO,
**PL, TVACB, NNB, MUD, VSTG, MPO,
**PL, TVACB, NNB, MUD, VSTG, MPO,
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DATAZX
DATAZX
DATAZX
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                                                                                                                                                                                                                                                                           ISLO,
                                                                                                                                                                                                                                                                                                                                              ISLB,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DATA2X
DATA2X
DATA2X
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DATA2 X
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             POW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             SIZING
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SIZING
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                                                                  TTOT2, TOT3, TOT4, TOT5, TOT6, TOT7, TOT8, TOT9, TO80, TO81, TO82, TO83, 81084

DIMENSION SKB(30), SCB(300), TB4(6), T82C(10), TB2T(6), TB34(6), 1 T848(10), T849(10), T850(10), T857(6), BMSAVE(10)

COMMON/ORBINN/

1 T81, T82, T83, T84, T85, T86, T87, T88, T89, T810, T811, T812, T813, T814, 2 T815, T816, T817, T818, T824, T822, T823, T824, T825, T826, T827, 3 1828, 1829, 1830, 1831, 1832, T823, T834, T835, T836, T837, T838, T839, T840, 4 T841, T842, T843, T844, T845, T844, T845, T845, T856, T857, T858, T853, T854, T857, T856, T851, T852, T853, 5 T854, T857, T856, T857, T858, T858, BMSAVE

6, T857, T860, T861, T862, T863, T864, T865, T866, T867, T868, T869, T870, T871, T872, T873, T874, T875, T876, T877, T878, T879, T880, T881, T882, 8T883, T884

COMMON/GLOBAL/

6R , CR , OMGZ , XLAMRF , YMURF , LUM
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ORBINY
CKOUT
ORBINY
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VEHOF
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20 OCT 72 6.01-46



```
IPC = 33

CALL TABIN(DUM, 1, A, 101, RUMMY, 1, ID, IPC, 0, IEOD)

IF(1EOD.NE.O) 60 TO 1

OO 3 I=1, 57

IF(NEGO(Å(1))) A(I)= PRESET(I)

3 CONTINUE

**** READ SYNTHESIS DATA ****

IF(NPRNT.EQ.I) WRITE(6, OATA2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CKOUT
CKOUT
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CKOUT
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VEHDF
VEHDF
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UH
VEHDF
                                                                                           ESTABLISH SYNTHESIS MORKING ARRAYS

1PSMAX=MIPSMX
5C(1) = IVAC8
5C(2) = FIRE + .1
5C(3) = BOOTW
5C(4) = DMXS
5C(5) = F8PAR
1F( FLYBEK .C.3.3.) SE(5)=0.
5E(6) = DMXX
5C(7) = IVACO
5E(8) = IFCTRB
5C(1) = IVACO
5E(8) = IFCTRB
5C(1) = NAFOB
5M(1) = SYNIT
5M(5) = TOLTM
5M(6) = TRATIO
5M(1) = SPC
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VEHDF
CKOUT
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JULY28
VEMDF
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VEHOF
VEHOF
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SUBRØUT I NE WTSCH

| FORTRAN | MATH | CODE | DESCRIPTION | STORAT | | <u> 5 ป 4 ค ก ป 1 1 1</u> | |
|---------|--------|------|--|------------|------|---|--------------------------------------|
| SYMBOL | SYMBOL | | DESCRIPTION | 91014 | rgc | รับงห์ เป็ | E VAR |
| | | | | | | | |
| ABFSYS | | M | Airbreathing fuel system meight used by setO to set common to zero | /WICALC/(| 1) | SETO O
WISCH N | C
ABFSYS |
| ANENGS | | 1 | Number of air breathing engines used by set0 to set common to zero | /CINPUT/(| 1) | FRENCH M
SETO O
STORE M
WTSCH I | A
ANENGS
A
ANENGS
ANENGS |
| ANTANK | | 1 | Number of air breathing fuel tanks | /CINPUT/(| 2) | STORE M
WTSCH I | ANT ANK |
| ASRATO | | ľ | Wing aspect ratio | /CINPUT/(| 3) | STORE M
WTSCH I | ASRATO
ASRATO |
| ASWEEP | | I | Wing leading edge sweep angle . | /CINPUT/(| 4 } | STORE M
WTSCH I | ASWEEP
ASWEEP |
| BBODY | | M | Body width used by setO to set common to zero | /VOLCAL/(| 1) | PROTHR I
SETO O
WTSCH M | BBODY
D
BBODY |
| C | | I | Input array c(300) of vehicle sizing data | | 5) | PRINTW I
PRITED I
PRITVA I
STORE M
WTSCH I
WTVOL O | 000000 |
| CSBODY | , | 1 | Body width coeff. | /CINPUT/(| 305) | PRITVA I
STORE II
WTSCH I | CBBODY - |
| CFUEL | | M | Mixture ratio | /CINPUT/(| 306) | PRWTSM M
STORE M
WTSCH M | CFUEL
CFUEL
CFUEL |
| CHBODY | • | İ | Body height or coeff | /CINPUT/(| 312) | PRITVA I
STORE M
WTSCH I | CHBODY
CHBODY
CHBODY |
| CLBOOY | | 1 | Body length or coeff | /CINPUT/(| 313) | PRITVA I
STORE M
WTSCH I | CLBODY
CLBODY
CLBODY |
| CRAP | | W | Temporary storage | /WTSCH /(* |) | WTSCH W | CRAP |
| CROOT | | M | Ing root chord | /VOLCAL/(| 2) | PROTHR I
Wisch M | CROOT |
| CSBODY | | 1 | Total body metted area or coeff | /CINPUT/(| | PRITVA I
STORE M
WISCH I | CSBODY
CSBODY
CSBODY |
| CSFAIR | | I | Fairing planform area or coeff | /CINPUT/(| | PRITVA I
STORE M
WTSCH I | CSFAIR
CSFAIR
CSFAIR |
| CSFUTK | | 1 | Fuel tank surface area or coeff | \CINPUT/(| | PRITVA I
STORE M
WTSCH I | CSFUTK
CSFUTK
CSFUTK |
| CSHORZ | | I | Horizontal stabalizer planform area | /CINPUT/(| | PRITVA I
STORE M
WTSCH I | CSHORZ
CSHORZ
CSHORZ |
| CSOXTK | | I | Oxidizer tank surface area coeff | /CINPUT/(| 318) | | CSOXTK
CSOXTK
CSOXTK |
| CSPAN | | M | Structural span along 0.5 chord | /VOLCAL/(| | PROTHR I
WTSCH M | CSPAN
CSPAN |
| CSPLAN | | I | Body planform area or coeff | /CINPUT/C | | PRITVA I
STORE M
WISCH I | CSPLAM
CSPLAN
CSPLAN |
| CSVERT | | 1 | Vertical fin-planform area or coeff | /CINPUT/(| | PRITVA I
S-TORE - M - | CSVERT |



| URTRAN | MAIH | cone | DESCRIPTION | STORA | GF | SURROUTIN | |
|------------|--------|------|---|------------|------|--|---|
| 2 A WHU I | SYMBUL | | DESCRIPTION , | BLUCK | LUC | SUBR COO | E VAR |
| CTHRST | | 1 | Vac. Thrust-to-meight ratio | //CINPUT/(| 322) | PRITVA I
STORE M
WTSCH I
WTVOL M | CTHRS1
CTHRS1
CTHRS1
CTHRS1 |
| CTHST2 | | 1 | Secondary propulsion t/m | /CINPUT/(| 323) | PRITVA I
STORE M
WTSCH I | CTHST:
CTHST:
CTHST: |
| CTIP | | 0 | Wing tip chard | /VOLCAL/(| 4) | WTSCH 0 | CTIP |
| FVACB | | m | Booster vacuum thrust (ib) | /TRUST /(| 5) | THRUST M
WTSCH M | FVACB
FVACB |
| F X WO VS | | 1 | fixed wing loading | /CINPUT/(| 329) | STORE M
WTSCH I | FXW0V
FXW0V |
| GAL | | M | Total gallons of fuel | /VOLCAL/(| 5) | WTSCH M | GAL |
| GSPAN | | M | Geometric ming span | /VOLCAL/(| 6) | WTSCH M | GSPAN |
| HBODY | | 0 | Body height | /VOLCAL/(| 7) | PROTHR I
WTSCH O | HBODY
HBODY |
| I S P | | I | Specific impulse | /CINPUT/(| 330) | PRWTSM I
STORE M
WTSCH I
WTVOL O | ISP
ISP
ISP
ISP |
| ITPS | | M | Thermo protection fing | /CINPUT/(| 336) | FRENCH O
Store M
Wisch M | ITPS
ITPS
ITPS |
| JUMP | | ı | Data flag 0= orbiter 1= booster | /JUMPY /(| 1) | FRENCH O
PRINTW I
PRITVA I
PRWTSM M
WTSCH I
WTVOL M | AWD CAMUL AWD CAMUL AWD CAMUL AWD CAMUL AWD CAMUL |
| L BODY | | M | Body length . | /VOLCAL/(| 8) | PROTHA I
TAMPER I
WTSCH M | LBODY
LBODY
LBODY |
| LF | | I | Ultimate load factor 1. Thrust buildup 2. Not used 3. Main impulse mass ratio 4. Main impulse reserve 5. Secondary impulse mass ratio 6. Not used | /CINPUT/(| 368) | STORE M
WTSCH I | LF
LF |
| MR | | M | Mass ratio | /CINPUT/(| 369) | PRWTSM I
SOLVE I
STORE M
WTSCH M | MR
MR
MR
MR |
| NCREW | | 1 | Number of cres members | /CINPUT/(| 375) | PRITVA I
STORE M
WTSCH I | NCREW
NCREW
NCREW |
| NENGS | | I | Total number engines per stage | /CINPUT/(| 376) | PRITVA I
STORE M
WTSCH I | NENGS
NENGS
NENGS |
| NL1STO | | 1 | Namelist output flag | /CINPUT/(| 377) | STORE M
WTSCH I | NLISTO
NLISTO |
| NP ASS | | I | Number of passengers | /CINPUT/(| 378) | STORE M
WTSCH I | NPASS
NPASS |
| AMF. | | Pt | Wing loading flag | /CINPUT/(| 379) | FRENCH D
STORE M
WTSCH M | NWL
NWL |
| CHAM | | I | Main rocket engine chamber pressure | /CINPUT/(| 380) | STORE M
WTSCH I | PCHAM
PCHAM |
|) | | м | Maximum dynamic pressure | /CINPUT/(| 3811 | WTSCH M | 0 |
| HOFU | | 1 | Fuel density | /CINPUT/(| 382) | PRITVA I
STORE M | RHOFU
RHOFU |
|
RHPFU2 | | 1 | Secondary fuel desnity | /CINPUT/(| | WTSCH I PRITVA I STORE MUTSCH I | RHOFU |

| PS | _ |
|----|---|
| | |

| ORTRAN | MAIH | CODE | DESCRIPTION | SIDRAG | | | | E USAGE |
|-----------|--------|--------|--|------------|------|--|------------------|--|
| SYMBUL | SYMBOL | | - OLSONII IION | BLOUK | LUL | 5ยคห (| COO | E VAR |
| RHOX | | i | Oxidizer density | /CINPUT/(| 384) | PRITVA
Store
Wisch | I
M
I | RHOX
RHOX
RHOX |
| R H O X 2 | | I | Secondary oxidizer density | /CINPUT/(| 385) | PRITVA
STORE
WTSCH | | RH0 X 2
RH0 X 2
RH0 X 2 |
| RTOD | | M | Deg to rad conversion | /VOLCAL/(| 9) | WTSCH | m | RTOD |
| SBODY | | M | Total body metted area | /CINPUT/(| 386) | PROTHR
TAMPER
WTSCH | I
I | 5800Y
5800Y
5800Y |
| SFAIR | | M | Total fairing or shroud surface area | /VOLCAL/(| 10) | WTSCH | M | SFAIR |
| SFUTK | | M | Total fuel tank metted area | /VOLCAL/(| 11) | PROTHR
WTSCH | I | SFUTK
SFUTK |
| SHORZ | | M | Horizontal stabilizer planform area | /VOLCAL/(| 12) | PROTHR
WTSCH | | SHORZ
SHORZ |
| SOXTK | | M | Total oxidizer tank metted area | /VOLCAL/(| 13) | PROTHR
WTSCH | I | SOXTK |
| SPLAN | | 0 | Body planform area | /VOLCAL/(| 14) | PROTHR
TAMPER
HTSCH
HTVOL | I | SPLAN
SPLAN
SPLAN
SPLAN |
| SORT | | F | Square root function | /SQRT /(\$ | , | ANLATM
CRASH
DCTOE
DENVPRM
HUNT
MODDELLA
OPWELL
OUT
PAYO2
PDY3A
STONVRT
WTSCH | FFFFFF | SORT
SORT
SORT
SORT
SORT
SORT
SORT
SORT |
| STPS | | M | Total thermal protection system surface area | /VOLCAL/(| | WTSCH | M | STPS |
| SVERT | | M | Vertical fin planform area | /VOLCAL/(| 16) | PROTHR
WTSCH | M | SVERT
SVERT |
| SWING | | M | Gross ming area , | /VOLCAL/(| 17) | PROTHR
Store
WTSCH | I
M
M | SWING
Swing
Swing |
| SXPOS | | 0 | Exposed sing area | /VOLCAL/(| 18) | PROTHR
WTSCH | I | S XPOS
S XPOS |
| TAN | | F | Tangent function | /TAN /(\$ | | WTSCH | F | TAN |
| TDEL | | M
- | Gimbal system delivered torque | /VOLCAL/(| | WTSCH | 19 | TDEL |
| TOVERC | | I | Wing thickness over choord ratio | /CINPUT/(| 388) | PROTHR
Store
WTSCH | I
M
I | TOVERC
TOVERC
TOVERC |
| TPRATO | | I | Wing taper ratio | /CINPUT/(| 389) | STORE
WTSCH | m
I | TPRATO
TPRATO |
| TROOT | | M | Theoritical root thickness | /VOLCAL/(| 20) | WTSCH | M | TROOT |
| 1101 | | M | Total stage vac. Thrust | /VOLCAL/(| 21) | PRITVA
STORE
WTSCH
WTVOL | I
I
M
I | 1101
1101
1101
1101 |
| TTOTAL | _ | . 0 | Total stage vac. Thrust / 1,000,000 | /VOLCAL/(| 23) | WTSCH | 0 . | TTOTAL |
| TT0T2 | | M | Total stage vac. Secondary thrust | /VOLCAL/(| 22) | PRITVA
WTSCH | | TT0T2
TT0T2 |

| FORTHAN
SYMBUL | MATH
Symbol | CODE | DESCRIPTION | STORAGE
BLOCK L | SUBROUTINE USAG
DC SUBR CODE VAR |
|-------------------|----------------|-------------|--|--------------------|---|
| VBODY | | m Totel bo | ody volume | /CINPUT/(3 | 91) PRINTY M VBODY SOLVE M VBODY TAMPER I VBODY WISCH M VBODY WITOU I VBODY |
| VBODYA | | m Total bo | ody volume less structure | /VOLCAL/(| 24) WTSCH M VBODY |
| VBODYX | | W Body vol | lune | /WTSCH /(+ |) WTSCH W VBODY |
| VBODY1 | | M Vbody to | o - 1/3 power | /VOLCAL/(| 25) WTSCH M VBODY
WTVOL M VBODY |
| VBODY2 | | M Vbody to | o - 2/3 power | /VOLCAL/(| 26) WTSCH M VBODY
WTVOL M VBODY |
| VCARGO | | M. Volume o | of cargo bay | /VOLCAL/(| 27) PRINTY I VCARE TAMPER I VCARE WTSCH M VCARE |
| VCREW | | M Volume o | of crew compartment | /VOLCAL/(| 28) PRINTY I VCREW
WTSCH M VCREW |
| VFUTK | | M Total vo | olume of fuel tank | /VOLCAL/(| 29) PRINTV I VFUTK
STORE M VFUTK
TAMPER I VFUTK
WTSCH M VFUTK |
| VFUTK2 | | M Total vo | olume of secondary fuel tank | /VOLCAL/(| 30) PRINTV I VFUTK
STORE M VFUTK
TAMPER I VFUTK
WTSCH M VFUTK |
| VINSTK | | M Total ta | onk insulation volume | /VOLCAL/(| 31) PRINTV I VINST
WTSCH M VINST |
| VLGBAY | | M Volume o | of recovery system bay | /VOLCAL/(| 32) PRINTV I VLGBA
WTSCH M VLGBA |
| VOXTK | | M: Total vo | olume of oxidizer tank | /VOLCAL/(| 34) PRINTV I VOXTK
STORE M VOXTK
TAMPER I VOXTK
WISCH M VOXTK |
| VOXTK2 | | M Total vo | olume of secondary oxidizer tank | /VOLCAL/(| 35) PRINTV I VOXTK
STORE M VOXTK
TAMPER I VOXTK
WTSCH M VOXTK |
| VPROP | | A Volume o | of propulsion bay | /VOLCAL/(| 36) PRINTV I VPROP
WTSCH M VPROP |
| VSTRUC | | M Volume o | of basic structure | /VOLCAL/(| 37) PRINTV I VSTRU
WTSCH M VSTRU |
| WABFPS | | W Weight o | of jp pressurization system | /WTSCH /(+ |) WTSCH W WABFP |
| WABFS | | 0 Weight o | of jp fuel system less tanks | /WTSCH /(+ |) WTSCH O WABFS |
| WABFTK | | M Weight o | of air breathing propulsion system tanks | /WTCALC/(| 2) PRINTW I WABFT WASFT |
| WABFU | | M Weight o | of jp fuel
- | /WTCALC/(| 3) PRINTW I WABFU PRWTSM M WABFU TAMPER I WABFU WTSCH M WABFU |
| WABPR | | M Weight o | of air breathing engines | /WTCALC/(| 4) PRINTW I WABPR
WTSCH M WABPR |
| WACRES | | শ Weight o | of attitude control fuel reserve | /WTCALC/(| 5) PRINTW I WACRE
STORE M WACRE
WTSCH M WACRE |
| WACS | | M Weight o | of attitude control system | /WTCALC/(| 6) PRINTW I WACS
WTSCH M WACS |
| WACSF | | ⊌ ⊌eighta | of attitude control fuel | /WTSCH /(+ |) WTSCH w WACSF |
| WACSFO | - | M Weight o | of attitude control fuel plus oxidizer | /WTCALC/(| 7) PRINTW I WACSF
STORE M WACSF
WTSCH M WACSF |
| WACSO | | ฟ Weight o | of attitude control oxidizer | /WTSCH /(+ |) WTSCH W WACSO |
| 30 OCT 72 | G.01-46 | | | | |

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| FOHTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | STORAGE | LOC | SUBROUTI
SUBR CO | |
|-------------------|----------------|--|------------|-----|---------------------------------|----------------------------|
| | | | | | | |
| WACSP | | W Weight of attitude control propellat | /WTSCH /(* |) | WTSCH W | WACSP |
| WACSTK | | M Weight of attitude control tankage | /WTCALC/(| | PRINTW I | WACSTK |
| | | · | | | WISCH M | |
| WAERD | | M Weight of serodynamic controls | /WTCALC/(| 9 1 | PRINTW I
WTSCH M | WAERO
Waero |
| TKUAW | | M Weight of separation system | /WTCALC/(| 10) | PRINTW I
STORE I
WTSCH M | TXUAW
TXUAW
TXUAW |
| WAVIOC | | O Total weight of avionic system | /WTSCH /(+ | , | WTSCH 0 | MAVIOC |
| WBASIC | | M Tatel weight of basic body | /WTCALC/(| 11) | PRINTW I
PROTHR I
WTSCH M | WBASIC
WBASIC
WBASIC |
| WBO DY | | M Total weight of body group | /WTCALC/(| 12) | PRINTW I
WTSCH M | MBODY |
| WBPUMP | | M Weight of boost and transfer pumps | /WTCALC/(| 13) | WTSCH M | WBPUMP |
| WCAR GO | | M Pavioad meight or cargo | /WTCALC/(| 14) | PRINTW I
WTSCH M | WCARGO
WCARGO |
| MCOMM | | M Communication system meight | /WTCALC/(| 15) | PRINTW I
WTSCH M | MCOWW
MCOWW |
| WCONT | | M Contingency and growth weight | /WTCALC/(| 16) | PRINTW I
TAMPER I
WTSCH M | WCONT
WCONT
WCONT |
| WCO VER | | M Total weight of thermal protection system cover panels | /WTCALC/(| 17) | PRINTW I
WTSCH M | WCDVER
WCOVER |
| WDECAY | | M Thrust decay propellant meight | /WTCALC/(| 18) | PRINTW I
STORE M
WTSCH M | MDECAY
WDECAY |
| WD1ST1 | | M Fuel system distribution meight ptl | /WTCALC/(| 19) | WTSCH M | WDIST1 |
| WDIST2 | | M Fuel system distribution weight pt2 | /WTCALC/(| 20) | WTSCH M | WDIST2 |
| MDOCK | | M Docking structure meight | /WTCALC/(| 21) | PRINTW I WTSCH M | MDOCK
MDOCK |
| M05F04 | | M Deployable aerodynamic device meight | /WTCALC/(| 22) | PRINTW I
WTSCH M | MOPLOY |
| WDRANS | | M. Fuel tank dump and drain seight | /WTCALC/(| 23) | WTSCH A | WDRANS |
| WDRY | | M Stage dry meight | /WTCALC/(| 24) | PRINTW I
TAMPER I
WISCH M | MDRY
MDRY
MDRY |
| WEMPTY | | M Stage empty melght | /WTCALC/(| 26) | WISCH M | WEMPTY |
| WENGMT | | M Engine mount weight | /WT CALC/(| 27) | WTSCH M | WENSMT |
| WENGS | | M Weight of rocket engines installed | /WTCALC/(| 28) | PRINTW I
WTSCH M | WENGS
WENGS |
| WENGS2 | | M Weight of secondary engines | /WTCALC/(| 29) | PRINTW I
WTSCH # | WENGS2
WENGS2 |
| WFAIR | | M Weight of fairings and shrauds | /WTCALC/(| 30) | PRINTW I
WTSCH M | WFAIR
WFAIR |
| WFCONT | | M Fuel system controls meight | /WTCALC/(| 31) | WTSCH M | WECONT |
| WFDCAY | | M. Thrust decay fuel meight | /WTCALC/(| 32) | WTSCH M | WFDCAY |
| WFAOST | | M Frost and ice meight | /WTCALC/(| 33) | PRINTW I
STORE M
WISCH M | WFROST
WFROST
WFROST |
| WFUEL | | M Fuel meight I. Thrust build~up fuel 2. Not used
3 Main impulse fuel mt. 4. Main impulse fuel
reserve 5. Secondary impulse fuel 6. Not used | /WTCALC/(| 37) | PRWTSM M
WTSCH M | WFUEL |
| WFUL | - | M Fuel weight | /WTCALC/(| 43) | PRINTW I
WTSCH # | WFUL
₩FUL |
| WFULOS | | M Vented fuel | /WTCALC/(| 44) | PRINTW I
STORE M
WISCH M | WFULOS
WFULOS
WFULOS |



| ORTRAN
Symbol | MATH
Symbol | COO€ | DESCRIPTION | BLOCK | LOC | SUBROUTIN
SUBR COD | |
|------------------|----------------|------------|---|-------------|-------|--|--|
| | | | | | | | |
| FUNCT | | m F | Fuel tank meight | /WTCALC/(| 45) | WTSCH M | WFUNC |
| WFUQX | | M | Welght _f main and secondary propellant | /WTCALC/(| 46) | PRINTW I
TAMPER I
WTSCH M
WTVOL I | WFUOX
WFUOX
WFUOX |
| NF URES | | m F | Fuel reserve | /WTCALC/(| 47) | PRINTW I
STORE M
TAMPER I
WTSCH M | WFURE:
WFURE:
WFURE: |
| IFUSYS | | m 1 | Fotal fuel system meight | /WTCALC/(| 48) | PRINTW I
WTSCH M | WFUSY: |
| IFUTK | | m u | Wit of non-structural fuel tankage . | /WTCALC/(| 49) | PRINTW I
WTSCH M | WFUTK
WFUTK |
| IFUTK2 | | M L | it of secondary fuel tank and system | /WTCALC/(| 50) | PRINTW I
WTSCH M | WFUTK: |
| FUTOT | | M T | Total meight of fuel | . /WTCALC/(| 51) | WTSCH M | WF UT 0 |
| JFUTRP | | m T | irapped fuel meight | /WTCALC/(| 52) | PRINTW I
STORE M
WTSCH M | WFUTRI
WFUTRI |
| JFU2 | | M, L | Jeight of secondary fuel | /WTCALC/(| 34) | PRINTW I
TAMPER I
WTSCH M | WFU2
WFU2
WFU2 |
| JGASPR | | M b | delight of gas and pressurant | /WTCALC/(| 53) | PRINTW I
STORE M
WTSCH M | WGASPI
WGASPI
WGASPI |
| IGNAV | | m 6 | Guidance and nevigation system #t | /WTCALC/(| 54) | PRINTH I
WTSCH M | WGNAV
WGNAV |
| MGR055 | | M 6 | Gross lift-off melght | /CINPUT/(| 392) | PRINTW I PRWTSM I SOLVE M STORE M TAMPER I WTSCH M WTVOL I | WGROSS
WGROSS
WGROSS
WGROSS
WGROSS |
| HORZ | | M H | dorizont al stabilizer et. | /WTCALC/(| 55) | PRINTW T
PROTHR I
WTSCH M | WHORZ
WHORZ
WHORZ |
| IHY CAD | | M H | lydraulic / pneumatic system #t | /WTCALC/(| 56) | PRINTW I
WTSCH M | WHY CAL |
| NI NF UT | | M L | leight of intergral fuel tank | /WTCALC/(| 57) | PRINTW I
PROTHR I
WTSCH M | WINFUT
WINFUT
WINFUT |
| TXONII | | M tu | Veight of integral oxidizer tank | /WT CALC/(| 58) | PRINTW I
PROTHR I
WTSCH M | MINOXI
WINOXI |
| INST | | M F | deight of instrument system | /WTCALC/(| 60) | PRINTW I
WTSCH M | WINST
WINST |
| INSTK | | M I | Total weight of tank insulation | /WTCALC/(| 59) | PRINTW I
WTSCH M | WINSTI
WINST |
| HET | | ,
L | Jettison weight 1. Ignition to lift-off 2. Not
used 3. Jettison during ascent 4. In-orbit
pettison wt. 5. Pre-entry jettison wt. 6. Fly-
pack jettison wt. | /WTCALC/(| | PRITVA I
PRWTSM M
STORE O
TAMPER I | HJET-
TJLW
TJLW
TJLW |
| ILANCH | | et L | aunch gear meight. | /WTCALC/(| | PRINTW I WTSCH M | WLANCH
WLANCH |
| LG | | m L | anding gear and controls weight | /WTCALC/(| . 69) | | WLG
WLG |
| IL <u>O</u> SS _ | | 0 I | n-flight meight loss | /WTCALC/(_ | 70) | | #F022 |



| ORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | BLOCK | LOC | SUBROUTINE | |
|------------------|----------------|----------|--|------------|------|---------------------------------|----------------------------------|
| 3 1 1180 C | 3111601 | | | BLUCK | | 308K C00E | |
| WLRD | | M | Launch and recovery system meight | /WTCALC/(| 71) | PRINTW I
WTS CH M | WLRD
WLRD |
| WNACEL | | M | Pylons, nacel, and pod weights | /WTCALC/(| 72) | PRINTW I
WTSCH M | WNACE
WNACE |
| MODCAY | | M | Oxidizer thrust decay weight | /WTCALC/(| 73) | WTSCH M | WODCA |
| M01 F | | M | Service Item losses | /WTCALC/(| 74) | PRINTW I
WTSCH M | MOIL
Moil |
| WOILRS | | M | Service Item reserves | /WTCALC/(| | PRINTW I
WTSCH M | WOILR |
| WORSUL | | M | Orientation, control, and separation system weight | /WTCALC/(| | PRINTW I
WTSCH M | WORSE
Worse |
| WO VERS | | M | Wing loading | /WTCALC/(| 77) | PROTHR I
TAMPER I
WTSCH M | MO VER
MO VER
MO VER |
| M () X | | M | Thrust build-up oxidizer 1. Thrust build-up oxidizer 2. Not used 3. Main impulse oxidizer 4. Main impulse oxidizer reserve 5. Secondary impulse oxidizer 6. Not used | /WTCALC/(| 78) | | MO X
MO X |
| MOXID | | M | Main impulse oxidizer meighter | /WTCALC/(| 87) | | MOXID |
| WOXLOS | | Ħ | Vented oxidizer | /WTCALC/(| 88) | STORE # | ₩0 X L O
₩0 X L O |
| JOXRES | | n | Oxidizer reserve | /WTCALC/(| 89) | TAMPER I | MOXRE
MOXRE
MOXRE |
| WOXSYS | | M | Oxidizer system weight | /WTCALC/(| 90) | | WOXSY |
| WOXTK | | n | Non-sturctural tank mt oxidizer | /WTCALC/(| 91) | PRINTW I
WTSCH M | MOXTK
WOXTK |
| WOXTK2 | | • | Secondary system oxidizer tank mt | /WTCALC/(| 92) | | MO X T K |
| MOXTOT | | M | Total weight of oxidizer | /WTCALC/(| | - | OTXOW |
| JOXTAP | | M | Trapped oxidizer weight | /WTCALC/(| 94) | | WOXTE
WOXTE |
| WOX2 | | M | Secondary oxidizer seight | /WTCALC/(| 84) | TAMPER I | W0 X2
W0 X2
W0 X2 |
| AP | | M | Total propellant meight | /WT CALC/(| 95) | WTSCH M | WP |
| JP ASS | | M | Weight of passengers | /WTCALC/(| 96) | | WPASS
WPASS |
| WPAYL | | M | Payload weight | /WTCALC/(| 97) | TAMPER I | WP AY L
WP AY L |
| WPERS | | | Crem gear and life support melght | /WTCALC/(| 98) | | WPERS
WPERS |
| MPOWCD | | M | Power conditioning equipment at. | /WTCALC/(| 99) | | ₩P0₩(
₩P0₩(|
| 4P0WF0 | | M | Power system propellant mt. | /WTCALC/(| 101) | | WP () WF
WP () WF
WP () WF |
| MPOWR5 | | M | Power system propellant reserve | /WTCALC/(| 102) | | WP () WF
WP () WF
WP () WF |
| MPOWTK | | A | Prime power system tank_meight | \MTCALC/(| 103) | | M D G M. |
| PPROV | | M | Personnel provisions | /WTCALC/(| 104) | | WPPR |

| FORTHAN | HIAN | CODE | DESCRIPTION | STORAG | | SUBBOUTIN | |
|---------|--------|------|---|-------------|------|--|----------------------------|
| SYMBOL | SYMBOL | | DE SOUTH LION | BLOCK | LOC | SUBH COD | E VAR |
| WPREIG | | m; P | Pre-ignition losses . | /WTCALC/(| 105) | PRINTW I
PRWTSM M
WTSCH .M | WPREIG
WPREIG
WPREIG |
| WPROP | | m T | otal meight- propulsion group | /WTCALC/(| 106) | PRINTW I
WTSCH M | WPROP
WPROP |
| WPRSYS | | M P | ressurization system melght | /WTCALC/(| 107) | PRINTW I
WTSCH M | WPRSYS
WPRSYS |
| WREFUL | | M F | uel system refueling system meight | /WTCALC/(| 108) | WTSCH M | WREFUL |
| WRESID | | M L | deight of residuals | /WTCALC/(| 109) | PRINTW I
WTSCH M | WRESID WRESID |
| WRESRY | | ri P | ropellant reservs | /WTCALC/(| 110) | PRINTW I
WTSCH M | WRESRY
WRESRY |
| WSEAL | | M F | uel tank seal weight | /WTCALC/(| 111) | WTSCH M | WSEAL |
| WSECST | | m S | econdary body structure mt | /WTCALC/(| 112) | PRINTW I
PROTHR I
WTSCH M | WSECST
WSECST
WSECST |
| USORCE | | M P | rime power system weight . | /WTCALC/(| 113) | PRINTU I
WTSCH M | WSORCE
WSORCE |
| USRTRP | | M T | rapped oxidizer weight | /WTCALC/(| 114) | PRINTW I
STORE M
WTSCH M | WSRTRP
WSRTRP
WSRTRP |
| WSTAB | | m E | ingine gimbal system #t | /WTCALC/(| 115) | PRINTW I
WTSCH M | WSTAB
WSTAB |
| WSURF | | M A | ero surface mt | /WTCALC/(| 116) | PRINTW I
WTSCH M | WSURF
WSURF |
| WTABC | | 0 N | let stage meight | /WTCALC/(| 117) | WTSCH 0 | MTABC |
| WTHRST | | m T | hrust structure øt | /WTCALC/(| 118) | PRINTW I
WTSCH M | WTHRST
WTHRST |
| WTO | | M T | ake- off meight | /WTCALC/(| 119) | PRINTW I
WTSCH M | WTO
WTO |
| WTPS | | M I | nduced environmental protection mt | /WTCALC/(| 120) | PRINTW I
WTSCH M | WTPS
WTPS |
| WTSCH | | | ubroutine to calculate meight and volume of both
tages | /WTSCH /(\$ | , | SOLVE S
WISCH E
WIVOL S | WTSCH
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| WVERT | | m v | ertical fin meight | /WTCALE/(| 121) | PRINTW I
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| HWAIT | | В | ummary meights 1. Ignition 2. Take-off 3.
urnout 4. Initial orbiter 5. Initial entry 6.
nitial flyback 7. Landing | /WTCALC/(| 122) | PRITVA I
PRWTSM I
STORE M
TAMPER I
WTSCH M | TIAMM
TIAMM
TIAMM |
| ww€T | | m 0 | perating weight-empty | /WTCALC/(| 132) | PRINTW I
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WISCH M | MMING
MMING |
| WZROFU | | m z | ero fuel meight of vehicle | /WTCALC/(| 134) | WISCH M | WZROFU |



FORTRAN STORAGE BLOCK L SUBROUTINE USAGE SUBH CODE VAR MATH DESCRIPTION CODE SYMBOL SYMBOL BLICO OBNDRYC OCRASH OFFENCH O .UNO6. .UNO6. . UN06. File of all output data /.UN06./(\$.UN06. .UNO6. .UNO6. .UNO6. .UN06. .UN06. .UN06. . UN06. . UNG6. . UNG6. .UNG6. .UNO6. .UNO6. .UNO6. PRWTSM O RANGE O . UN06. .UN06. .UN06. RANGE O
SOINP O
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SIZIN O
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STAU O .UNO6. .UNO6. .UNO6. .UNO6. .UNO6. .UNO6. STPIT O SUMOUT O TABIN O TEST O .UN06. .UN06. TABIN TEST VEHDF WTSCH WTVOL . UNO6. . UN06. 000 . UNG6. .UN06.



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WTSCH
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                                                                                              WISCH SUBROUTINE REPROGRAMED BY WALTER O. HONEYCUTT AND B. H. ORAN ON 9/17/70 INPUT DECKS PRIOR TO THIS DATA ARE NO LONGER VALID
                                                                                REAL MUB. MUD. ISPB, ISPD, IOVEL, NNB, NO COMMON /SIZING/
PHASE II SIZING PARAMERERS

*TZ. YV33), OP(14), ENDR, PZ.

*SV(28), SQ(37)3, SE(11), TLAT, T.

*MBD, PHASE ISIZING PARAMERERS

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TLNG,
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IPASS,
ISPO,
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ITNOW
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ISIZE,
PRFLG,
IDVEL,
WEB,
VSTG,
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IPSMAX,
ISPB,
HLO,
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CSFUTK
CTHST2
LF
PCHAM
TOL
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CSHORZ
DEF(5)
MR(6)
Q
TOVERC
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FXWOVS ,
WCREW ,
RMOFU ,
TPRATO ,
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SXPOS
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VLGBAY
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SOXTK
TROOT
YCARGO
YOXTK
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, WCOVER
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, WBASIC
, WDECAY
, WELCAD
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, WOIST1
, WEAPTY
, WFROST
, WFURES
, WGMAY
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MORY
MF LONG
MF LUNCT
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WINOXT
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MFUTKZ
MINFUT
MING
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MOXSYS
MPAYL
MPAYL
MSEAL
MTHRST
MZROFU
MACOTP
MACOTP
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, WLANCH
, WOILRS
, WOIRES
, WPASS
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WODCAY
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2 MP
3 MPO MRS
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, WYERT
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WREFUL
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WTABC
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, WAUFTP
, WGAS
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SWWET
TWANDRS
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59.
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MTSCH
MTSCH
CKOUT
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                                                                                      COMMON/JUMPY/JUMP, WBIG, WBOO
COMMON /TRUST/
• FYACO, FSLO, FYACLO,
•FYACB, FSLB, FSLLO,
 61.
62.
63.
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65.
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FSLS
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WTSCH
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                                                                                        NAMELIST/MASS1/
1ABFSYS ,BBODY
2MBODY ,BBODY
3SPLAN ,STPS
4TTOT ,TTOT2
5YCREW ,YFUTK
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, GTOD
, SVERT
, TTOTAL
, VFUTKZ
, VSTRUC
, WACSTK
, WCOMM
, WCOMM
, WENGS2
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SFAIR
SWING
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VINSTK
WABFTK
WABFTO
WCONT
WDRAYS
WFAIR
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SFUTK
SXPOS
VBDDV1
VLGBBU
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WAUXT
WCOVER
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SHORZ
TOEL
YBODY2
YOTHER
WABPR
WBASIC
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, BBODY
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, TTOT2
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, VOXTK
, WACRES
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SWBPUMP , WCARGO
PUDIST2 , WDOCK
FWENGMT , WENGS
WAMELIST/MASS2/
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8WBPUMP
9WDIST2
#WENGMT
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MEMPTY
MFROST
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WFULOS
WFUTOT
WIODXT
WLOSS
WOVERS
WDITK
WPREIG
WSECST
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WFUTRP
WINSTK
WLRD
WOXTK2
WPOWCD
WPROP
WSORCE
WTPS
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WGASPR
WINST
WNACEL
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WDYWER
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WGNAY
WINSUL
WODCAY
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WPPROV
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+WOXLOS
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+WSURF
+WET
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WTABC
WWING
                                                                                     INITALIZE VARIABLES
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MTSCH
MTSCH
CKOUT
MTSCH
MTSCH
MTSCH
MTSCH
                                                                                   MTD=MEBOSS
                                                                                   Q = SE(6)
C13=1./3.
C23=2./3.
                                                                                     RTOD=57.3
                                                                                     WPREIG=C(134)
WWAIT(1)=WGROSS-WPREIG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL TOTAL 
      101.
                                           00000
                                                                                                         CALCULATE PROPELLANT WEIGHTS
      103.
                                                                                     COMPUTE FUEL PERCENTAGE
   105.
106.
107.
108.
                                                                                     DO 10 I=1,6
                                           ε
                                                                                     IF (CFUEL(I).GE.1.0) CFUEL(I)=1./(CFUEL(I)+1.)
                                            CCC
                                                                                   C
                                                                10 CONTINUE
  116.
117.
118.
119.
120.
121.
122.
123.
124.
125.
126.
127.
128.
                                                                                      COMPUTE JETTSION WEIGHT
                                                                             MJET(1)=0.0

MJET(2)=0.0

IF(JUMP.E0.0)

1 MJET(3)=MFROST + C(127)

MJET(4)=MSRTRP + MDECAY + MFURES + MOXRES

+ C(296)

MJET(5)=MACSFO + C(76) + MGASPR + MFULOS + MOXLOS

MJET(6)=MPOMFO - C(127)

MFUL=0.0

MOXID=0.0
130.

131.

133.

134.

135.

136.

137.

139.

140.

141.

142.

143.

144.

145.

146.

147.

148.

149.

150.
                                                                                     COMPUTE PROPELLANT MEIGHT
                                                                                     DO 40 I=1,4
                                           C
                                                                                     WFU0X=0.
IF (MR(I).NE.O.) WFU0X=WWAIT(I)+(MR(I)+1.)/MR(I)
                                                                                      COMPUTE FUEL WEIGHTS
                                                                                     WFUEL(I)=WFUOX+CFUEL(I)
                                            CCC
                                                                                      COMPUTE LOX WEIGHTS
                                                                                      #0x(1)=#FUOX-#FUEL(1)
                                           000
                                                                                      THRUST BUILD UP-PROPELLANTS INPUT CONSTANT
                                                                                      IF (I.NE.1) 60 TO 30
                                            C
                                                                                      WFUEL(1)=WFUEL(1)+C(132)
```

• - -

30-

| SI | | | | |
|----------------------------------|--|-------------------------------------|--|--|
| 155. C COMPUTE VEMICLE WEIGHTS | 1152. | _ C | | WTSCH |
| 172 | 155.
156.
157.
159.
1623.
165.
1667.
1689. | 000 0000 000 | COMPUTE VEHICLE WEIGHTS IF(I.EQ.4) GO TO 40 WWAIT(I+1)=WWAIT(I)-WFUDX-WJET(I) SUM FUEL WEIGHTS WFUL=WFUL+WFUEL(I) SUM LOX WEIGHTS | #TSCH
#TSCH
#TSCH
#TSCH
#TSCH
#TSCH
#TSCH
#TSCH
#TSCH
#TSCH
#TSCH
#TSCH
#TSCH
#TSCH |
| 214. C | 1771-1775-11871-1775-11871-1775-11871-1775-11871-1775-11871-17778-118871-17778-11871-17978-11978 | a ana ana ana ana ana ana ana ana a | TO CONTINUE WHALT(5)=WHALT(4)-WJET(4) COMPUTE TOTAL THRUST IF(JUMP.EQ.0) TTOT= FVACO IF(5E(3). EQ.1.) FVACB=0. IF(JUMP.EQ.1) TTOT= FVACB + CTHRST+WHALT (3) + C(232) TOTAL THRUST/1000000. COMPUTE SECONDARY THRUST TTOT2=WHALT(4)+CTHST2+C(15B) COMPUTE ACS PROPELLANTS WACSFO=C(173)+WTO+C(174)+WHALT(4)+C(175) COMPUTE POWER SOURCE PROPELLANTS WPOWFO=C(38)+WHALT(6)+C(127) COMPUTE SERVICE ITEM LOSSES WGIL=C(130)+TTOT+C(131) COMPUTE MAIN FUEL RESERVES WFURES=C(115)+WFUEL(3)+C(116) + WFUEL(4) COMPUTE ANIN LOX RESERVES WOXRES=C(117)+WOX (3)+C(118) +WOX(4) COMPUTE ACS PROPELLANT RESERVE WACRES=C(172)+WACSFO+C(73) | |
| | 214.
215.
216.
217.
218.
219.
220.
221.
222.
223. | 000 000 | MPOWRS=C(119)+MPOWFO+C(120) COMPUTE SERVICE ITEM RESERVES MOILRS=C(121)+MOIL+C(122) SUM PROPELLANT RESERVES | WTSCM WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH |

| 225. | C | COMPUTE SECONDARY FUEL MEIGHT | WTSCH
WTSCH | |
|--------------|----|--|------------------|------------|
| 226. | Ľ | WFU2(1)=0.0 | WISCH | ŀ |
| 228. | | W0 X2(1)=0.0 | WTSCH | ١ |
| 229. | | 1F (MR(5).EQ.0.0) 60 TO 45 | WISCH | 45. |
| 230.
231. | | WFU2(1)=WWAIT(4)=(MR(5)-1,)/MR(5)=(| WTSCH
WTSCH | l |
| 232. | С | ar util 3 1-at at 1 1 | WTSCH | 1 |
| 233. | C | COMPUTE SECONDARY LOX WEIGHT | MTSCH
WTSCH | Į |
| 234. | C | WOX2(1)=WWAIT(4)+(MR(5)-1.)/MR(5)+(1CFUEL(5)) | WTSCH | |
| 236. | | WOX(5)=WOX2(1) | WTSCH | L |
| 237.
238. | | 45 CONTINUE WPOMS=WFU2(1) + WDX2(1) | MTSCH
MTSCH | |
| 239. | Ç | | WTSCH | ı |
| 240.
241. | C | COMPUTE TOTAL FUEL WEIGHT LESS TRAPPED AND LOSSES | MTSCH
MTSCH | 1 |
| 242. | | WFUTOT=0.0
IF (C(109).WE.1.0) WFUTOT=(WFUL+WFURES+C(110))/(1C(109)) | WTS CH
WTS CH | l |
| 244. | Ç | · | MT S CH | |
| 245.
246. | C | COMPUTE TOTAL LOX WEIGHT LESS TRAPPED AND LOSSES | WTSCH
WTSCH | \ ′ |
| 247. | · | MOXTOT=0.0 | MTSCH | l |
| 248.
249. | | IF (C(1)1).ME.1.0) WDXTOT=(WDXID+WDXRES+C(1)2))/(1C(1)1)) | WTSCH
WTSCH | |
| 250. | C | SUM PROPELLANT WEIGHT LESS LOSSES AND TRAPPED | WTSCH | l |
| 251. | C | | MTSCH | |
| 252.
253. | C | MP=MFUTQT+MOXTQT | WTSCH
WTSCH | 1 |
| 254. | Č | COMPUTE FUEL LOSSES | WTSCH | [|
| 255.
256. | C | MFULDS=C(123)+MFUTOT+C(229)+MP+C(124) | WTSCH
WTSCH | 1 |
| 257. | | 1 + C(299)+MPOMS | WTSCH | • |
| 258. | Ç | ************************************** | WISCH | 1 |
| 259. | C | COMPUTE LOX LOSSES | WTSCH
WTSCH | l |
| 261. | | MDXLDS=C(125)+M0XTOT+C(230)+MP+C(126) | WTSCH | 1 |
| 262. | C | SUM TOTAL FUEL WEIGHT AND LOSSES | WTSCH
WTSCH | 1 |
| 264. | ·Č | MFUTOT=MFUTOT+MFULOS | WTSCH
WTSCH | ! |
| 265.
266. | C | MLDIDI-MLDIDIAMACTO2 | WTSCH | ł |
| 267. | C | SUM TOTAL LOX WEIGHT AND LOSSES | WTSCH
WTSCH | |
| 269. | | WOXTOT=WDXTOT+WOXLOS | WTSCH | |
| 270.
271. | C | SUM PROPELLANT WEIGHT LESS TRAPPED | WTSCH
WTSCH | |
| 272. | С | MP=MFUTOT+MOXTOT | WTSCH
WTSCH | ł |
| 274. | C | | WTSCH | 1 |
| 275. | C | COMPUTE TRAPPED FUEL MEIGHT | WTSCH
WTSCH | Į |
| 277 | • | WFUTRP=C(109)+WFUTDT+C(225)+WP+C(226)+TTDT +C(110) | MTSCH | l |
| 278. | _ | 1 + C(300)=MPOMS | ₩TSCH
₩TSCH | l |
| 279.
280. | C | COMPUTE TRAPPED LOX WEIGHT | HISCH | ł |
| 281. | č | | WTSCH | l |
| 282.
283. | c | HOXTRP=C(111)=HOXTOT+C(227)=HP+C(228)=TTOT +C(112) | wtsch
Wtsch | 1 |
| 284. | Č | COMPUTE THRUST DECAY PROPELLANTS | WTSCH | l |
| 285.
286. | C | WDECAY=C(166)+TTOT+C(167) | WTSCH
WTSCH | l |
| 287. | | WFDCAY=WDECAY+CFUEL(3) | MTSCH | ł |
| 288. | _ | WODCAY=WDECAY-WFDCAY | MISCH | ı |
| 289. | C | COMPUTE TOTAL FUEL WEIGHT | ¥TSCH
¥TSCH | 1 |
| 291. | č | | WTSCH | l |
| 292.
293. | ε | WFUTOT=WFUTOT+WFUTAP+WFDCAY | WTSCH
WTSCH | ١. |
| 294. | С | COMPUTE TOTAL LOX WEIGHT | WTSCH | 1 |
| 295. | С | MOXTOT=MOXTOT+MOXTRP+MODCAY | MTSCH
MTSCH | |
| 1207 | C | | MTSCH | 1 |
| 297.
298. | č | COMPUTE TANK PRESSURIZATION AND PURGE GASES | WTSCH | |

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WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
300.
301.
302.
303.
304.
305.
306.
                      WGASPR=C(106)+VFUTK+C(107)+VOXTK+C(108)
           CCC
                      COMPUTE TRAPPED SERVICE ITEMS
                     WSRTRP=C(113)+WWAIT(1)+C(114)
                     COMPUTE ICE AND FROST
308.
309.
310.
311.
313.
314.
315.
317.
318.
319.
320.
321.
322.
323.
                     WFROST=C(78)
                                                                                                                                          WTSCH
WTSCH
WTSCH
           CCCC
                     SUM ENTRY WEIGHT
                                                                                                                                          WTSCH
WTSCH
WTSCH
WTSCH
                     WWAIT(6)=WWAIT(5)-WFUEL(5)-WOX(5)-WJET(5)
           CCC
                      COMPUTE AIR BREATHING FUEL
                                                                                                                                          WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
                      HABFU=0.0
HABFU=C(215)+C(214)/(1.+C(214))+WMAIT(6)
           CCC
                      COMPUTE AIR BREATHING FUEL TANK VOLUME
                      IF(RHOFU.EQ.O.O.OR.MMAIT(6).EQ.O.O) GO TO 9999
IF(ANTANK.GT.O.O) GO TO 9999
IF(C(212).NE.O.O.OR.C(213).NE.O.O) K(28)=MABFU/RHOFU
                                                                                                                                                       9999-
                                                                                                                                          WISCH
WISCH
WISCH
WISCH
WISCH
WISCH
WISCH
WISCH
WISCH
WISCH
325.
             9999 CONTINUE
CCC
                      SUM LANDING WEIGHT
                      WMAIT(7)=HWAIT(6) - WABFU - WJET(6)
          0
                    WTO=WMAIT(1)-WFUEL(1)-MOX(1)
WFUOX=WFUL+WOXID+WFU2(1)+WOX2(1)
WRESID=WFUTRP+WOXTRP+WGASPR+WSRTRP
WLOSS-WFULOS+WOXLOS+WACSFO+WPOWFO+WDIL+WABFU+WFROST
1 + C(296)
                                                                                                                                          WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
          00000000
                     *****
                                   GEOMETRY SECTION
                      *****
                                                                                                                                          WTSCH
WTSCH
WTSCH
                      COMPUTE BODY VOLUME TO THE 1/3 POWER
                                                                                                                                          WTSCH
WTSCH
WTSCH
WTSCH
                      IF( VBODY.LE.O.O) VBODY=1.0 VBODY1=VBODY++C13
           CCC
                                                                                                                                          WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
                      COMPUTE BODY VOLUME TO THE 2/3 POWER
                      VB0DY2=VB0DY1++2
           CCC
                      COMPUTE LOX TANK VOLUME
                      VOXTK=0.0
IF (RHOX.NE.O.) VOXTK=(WOXTOT/RHOX)=(K(2)+1.)+K(29)
                                                                                                                                           MTSCH
MTSCH
MTSCH
           CCC
                      COMPUTE FUEL TANK VOLUME
                                                                                                                                          WTSCH
WTSCH
WTSCH
WTSCH
                      VFUTK=0.0
IF (RHOFU.NE.O.) VFUTK=(WFUTOT/RHOFU)+(K(1)+1.)+K(28)+K(21)
           CCC
                                                                                                                                          MTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
                      COMPUTE FUEL TANK SURFACE AREA
                    SFUTK=0.0

IF(VFUTK.GT.0.0)

1SFUTK=CSFUTK+VFUTK++C23
           CCC
                      COMPUTE LOX TANK SURFACE AREA
                    SOXTK=0.0
IF(VOXTK.GT.0.0)
150XTK=CSOXTK+VOXTK++C23
```

| 1 | | | | - |
|--|--------|---|---|-------------|
| 375.
376. | C | COMPUTE PROPELLANT TANKS INSULATION VOLUME | WTSCH
WTSCH | |
| 377. | | VINSTK=K(3)+SFUTK+K(4)+K(25)+SONTK | WTSCH | |
| 378.
379. | C | COMPUTE SECONDARY FUEL TANK VOLUME | WTSCH | 1 |
| 380.
381. | C | VFUT#2=#(7) | WTSCH
WTSCH | |
| 382.
383. | | ₩FUL2=WFU2(1)
WDXD2=WDX2(1) | WTSCH
WTSCH | l |
| 384. | | IF(JUMP .ST. 0.0) GO TO 38 | WTSCH | 38 |
| 385.
386. | | IF(C(270) .LE. 0.0) 60 TO 37
DVS1Z2=C(270) | WTSCH
WTSCH | 377 |
| 387.
388. | | S SP2=C(271)
CHINJ=C(272) | WTSCH
WTSCH | 1 11 |
| 389.
390. | | 0F0M5=C(273) | WTSCH | 1 11 |
| 391. | | R2=EXP(DV51I2/(32.17405+S15P2))
W02=CW1N+WWAIT(4) | WTSCH
WTSCH | 1 11 |
| 392.
393. | | WC2=W02/R2
WP2=W02-WC2 | WTSCH
WTSCH | 1 11 |
| 394.
395. | | WFULZ=WP2/(1.0+0F0MS)
W0x02=WP2-WFUL2 | WTSCH
WTSCH | 1 1 |
| 396. | | 37 CONTINUE | MISCH | ╂┻┦ |
| 397.
398. | | IF(C(164).GT.O.O.OR.C(165).GT.O.O) 60 TO 38
OFACS=C(34) | WTSCH
WTSCH | 38- |
| 399. | | WACSP=WACSFO + WACRES | WTSCH | 1 |
| 400. | | WACSF=WACSP/(1.0 + OFACS)
WACSO=WACSP - WACSF | WTSCH | 1 1 |
| 402.
403. | | MFUL2≈MFUL2 + MAČŠF
MOXD2= MOXD2 + MACSO | WTSCH
WTSCH | 1 1 |
| 404. | | 38 CONTINUE | MISCH | |
| 405. | | IF(RNOFU2.NE.O.O)
14FUTK2=MFUL2/RNOFU2 | WTSCH
WTSCH | ì |
| 407.
408. | C | COMPUTE SECONDARY OXIDIZER TANK VOLUME | UTSCH
UTSCH | İ |
| 409. | č | V0XTK2=K(8) | HTSCH
HTSCH | |
| 411. | | IF(RHOX2.NE.O.O) | WTSCH | ĺ |
| 412. | Ç | 1 VOXTK2=W0XD2/RM0X2 | WTSCH
WTSCH | 1 |
| 414.
415. | Č | COMPUTE PROPULSION SYSTEM VOLUME | WTSCH
WTSCH | l |
| 416. | c | VPROP=K(16)+TTOT+K(17) | WISCH | i |
| 418. | C | COMPUTE CARGO VOLUME | WTSCH | 1 |
| 419.
420. | 3 | VCARGO=K(9) | WTSCH
WTSCH | Į |
| 421.
422. | C | COMPUTE CREW VOLUME | WTSCH
WTSCH | 1 |
| 423. | č | VCREW=K(5)*NCREW+K(6) | WTS CH
WTS CH | |
| 425. | Ç | 10.2 | WTSCH | l |
| 426.
427. | ç | COMPUTE LANDING SEAR BAY VOLUME | WTSCH
WTSCH | 1 |
| 428.
429. | ε | VLGBAY=K(12)+WLG+K(13) | WTSCH
WTSCH | i |
| 430.
431. | Č | COMPUTE VBODY, VOTHER, SBODY AND VSTRUC USING K(18) SCALING DATA | WTSCH | |
| 432. | · | IF(K(18).LE.1.0) GO TO 46 | WTSCH | 46-7 |
| 433. | | VBODY=K(18)+(YFUTK+VDXTK)+K(23)
VOINER=YBOOY-YFUTK-VOXTK-VINSTK-VCREW-VCARGO-VSTRUC-VL6BAY-YPROP | WTSCH | 1 1 |
| 434. | | VFUTK2-V0XTK2
SB0DY=C5B0DY+VB0DY++C23 | WTSCH
WTSCH | 1 1 |
| 434.
435.
436. | | | | 1 1 |
| 434.
435. | | VSTRUC=K(10)+SBODY+K(11)
GO TO 40 | WTSCH
WTSCH | 160 |
| 434.
435.
436.
437.
438. | | ŸSTRUC=K(10)+SBODY+K(11) | WTSCH | ۰۰ ا |
| 434.
435.
436.
437.
438.
440.
441. | C C | VSTRUC=K(10)+S80DV+K(11)
60 TO 40 | WTSCH
WTSCH
WTSCH | |
| 434.
435.
436.
437.
438.
439.
440.
441. | C C C | VSTRUC=K(10)+SB0DV+K(11) GO TO 60 46 CONTINUE SAVE BODY VOLUME | WTSCH
WTSCH
WTSCH
WTSCH
WTSCH | " |
| 434.
435.
436.
437.
438.
440.
441.
442.
443. | C
C | VSTRUC=K(10)+SB0DV+K(11) GO TO 60 46 CONTINUE SAVE BODY VOLUME VBODYX=VBODY | WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH | " |
| 434.
435.
436.
437.
438.
440.
441.
442. | C | VSTRUC=K(10)+SB0DV+K(11) GO TO 60 46 CONTINUE SAVE BODY VOLUME | WTSCH
WTSCH
WTSCH
WTSCH
WTSCH | |

| | | | | | , |
|-------------------|--------------|----|---|-------------------------|------|
| 449
450
451 | D. C | | COMPUTE BODY SURFACE AREA | WTSCH
WTSCH
WTSCH | |
| 452 | | 50 | SBODY=CSBODY+VBODY2 | HTSCH | |
| 454 | 4. C | | COMPUTE STRUCTURAL VOLUME | MTSCH
MTSCH | |
| 455 | | | VSTRUC=K(10)+SB0DY+K(11) | MTSCH
MTSCH | 1 1 |
| 451 | ı. C | | 43.40C-W(10.4-20001.4K(18.) | WTSCH | } |
| 456 | | | VOTHER=K(18)+(VBODY-VCARGO-VSTRUC)+K(19) | WTSCH
WTSCH | |
| 1460 |). C | | | WTSCH | |
| 461 | 1. C | | SUM BODY VOLUME | WTSCH
WTSCH | |
| 463 | 3. | | VBDDY=VBODYA+VSTRUC+VOTHER | WTSCH | 1 1 |
| 461 | | | 1F(VBODY.LE.O.O) VBODY=1.0 | WTSCH
WTSCH | 1 1 |
| 466 | 6. | | 1F(ABS(VBODYX-VBODY).LE.2.0) GO TO 60 | MTSCH
MTSCH | 60- |
| 468 | B. C | | SAVE BODY VOLUME | WTSCH | |
| 469 |). C | | ABODA X=ABODA | WTSCH
WTSCH | 1 |
| 471 | 1. C | | | WISCH | 1 |
| 472 | 2. C
3. C | | UPDATE BODY VOLUME TO THE 2/3 POWER | MTSCH
MTSCH | |
| 474 | ۹. | | IF(VBODY.LE.O.Q) VBODY=1.0 | WTSCH | 1 |
| 475 |).
5. C | | ¥80DY2=¥B0DY••C23 | WTSCH
WTSCH | |
| 477 | 1. | | 60 TD 50 | WTSCH | 50 |
| 478 | B. C | | UPDATE BODY VOLUME TO THE 1/3 POWER | WTSCH
WTSCH | |
| 480 |). <u>C</u> | | | WTSCH | |
| 481 | l.
2. C | 60 | 480DY1=480BY++C13 | WTSCH
WTSCH | |
| 483 | 3. C | | UPDATE BODY VOLUME TO THE 2/3 POMER | WTSCH | |
| 484 | i. C | | VBODY2=VBODY1++2 | WTSCH
WTSCH | |
| 486 | 6. C | | | WTSCH | |
| 488 | | | IF(NWL.LE.O.OR.NWL.GE.8) NWL=6 | WTSCH
WTSCH | |
| 489 | i. č | | TEST FOR WING SIZE METHOD-IF INPUT WING LOADING (FXWDVS) NOT EQUAL | MTSCH | |
| 490 |). C | | TO ZERO SIZE ON INPUT -IF INPUT WING LOADING EQUAL ZERO USE INPUT WING AREA | WISCH | |
| 492 | 2. C | | | WTSCH | |
| 494 | 4. C | | IF(FXMOVS.NE.O.O) 60 TO 70 | MTSCH
MTSCH | 100 |
| 499 | 5. C
5. C | | VARIABLE WING LOADING | WTSCH
WTSCH | |
| 497 | 7. | | MO VERS=0.0 | MTSCH | |
| 496 | | | IF (SWING.NE.O.O) WOVERS=WWAIT(NWL)/SWING | MTS CH | |
| 500 | ٥. | | 60 TO 80 | WTSCH | 80-7 |
| 501 | 1. C
2. C | | FIXED WING LOADING | MTSCH
MTSCH | l II |
| 50 | 3. č | | | WTSCH | |
| 504 | | 70 | SWING=WWAIT(NWL)/FXWDVS | MISCH | |
| 505 | | | WOVERS=FXWOVS | WTSCH
WTSCH | 1 |
| 50 | 7. C | | COMPUTE AERO WING SPAN | MISCH | |
| 508 | | 00 | CCQAN-A A | MISCH | |
| 1516 | | 80 | GSPAN=0.0
1f((asrato≠swing).gt.o.o) | MTSCH
MTSCH | |
| 511 | ١. | | 1GSPAN=(ASRATO+SMING)++.5 | WTSCH
WTSCH | l |
| 1513 | 3. C | | COMPUTE WING ROOT CHORD | WTSCH | |
| 514
515 | 4. C | | CROOT=0.0 | WTSCH
WTSCH | |
| 516 | ١. | | IF (TPRATO.ME1.0) CROOT=2.*SWING/((1.+TPRATO)*GSPAN) | WISCH | |
| 517 | | | COMPUTE WING TIP CHORD | WTSCH
WTSCH | |
| 519 | 9. C | | | MISCH | |
| 520 | ٥. | | CTIP=CROOT+TPRATO | MTSCH
MTSCH | |
| 1221 | . · | | | -1368 | ľ |

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522.
523.
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531.
533.
         C
                   COMPUTE WING STRUCTURAL SPAN SOPC
                                                CSPAN=GSPAN/COS(ATAN(TAN(ASWEEP/RTOD)-(.5+CROOT
                  1+(1.+TPRATO)/(GSPAN/2.))))
                                                                                                                             WTSCH
WTSCH
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WTSCH
         CCC
                   COMPUTE WING THICKNESS AT ROOT
                   TROOT=TOVERC#CROOT
         CCC
                   COMPUTE BODY WIDTH
                                                                                                                             WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
                   BBODY=CBBODY=VBODY1
         CCC
536.
537.
538.
539.
540.
                   COMPUTE WING EXPOSED AREA
                  IF((.5+BBODY).GT.O.O)
1SXPOS =SWING-(CROOT+BBODY-(.5+BBODY)++2+TAN(ASWEEP/RTOD))
         CCC
COMPUTE HORIZONTAL TAIL AREA
                                                                                                                             WTSCH
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                   SHORZ=CSHORZ+SWING
         CC
                   COMPUTE BODY SURFACE AREA
                   SBODY=CSBODY#VBODY2
         CCC
                   COMPUTE VERTICAL TAIL AREA
                   SVERT=CSVERT+VBODY2
772.
553.
554.
555.
556.
         CCC
                   COMPUTE FAIRING AREA
                   SFAIR=CSFAIR+SBODY
                                                                                                                             WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
WTSCH
         CCC
                   PLANFORM AREA
                   SPLAN=CSPLAN+VBODY2
         CCC
562.
563.
                   COMPUTE BODY HEIGHT
                                                                                                                             WTSCH
WTSCH
WTSCH
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WTSCH
564.
565.
566.
567.
568.
569.
                   HBODY=CHBODY+VBODY1
         CCC
                   COMPUTE BODY LENGTH
                   LBODY=CLBODY+VBODY1
         0000
                                                                                                                             WTSCH
WTSCH
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WTSCH
571.
572.
573
574
                   COMPUTE THERMAL PROTECTION AREA
                   IF(ITPS.LT.1.OR.ITPS.GT.8) ITPS=1
60 TO (90,100,110,120,130,140,150,160), ITPS
                                                                                                                                          90-100-110-120-130-140-150-
575.
576.
               90 STPS(1)=0.
60 TO 170
                                                                                                                             WTSCH
WTSCH
                                                                                                                                          170-
511.
518.
             100 STPS(1)=5BODY
GO TO 170
                                                                                                                             WTSCH
WTSCH
                                                                                                                                          170
             110 STPS(1)=SBODY+SHORZ
60 TO 170
579.
580.
                                                                                                                             WTSCH
WTSCH
                                                                                                                                          170
             120 STPS(1)=SBODY+SHORZ+SVERT
GO TO 170
581.
582
                                                                                                                             WTSCH
WTSCH
                                                                                                                                          170
583
584
             130 STPS(1)=SBODY+SHORZ+SVERT+SWING
GO TO 170
                                                                                                                             MTSCH
WTSCH
                                                                                                                                          170-
585.
586.
             140 STPS(1)=SHORZ+SVERT+SWING
GO TO 170
                                                                                                                             MTSCH
WTSCH
                                                                                                                                          170
587.
             150 STPS(1)=580DY+SWING
60 TO 170
                                                                                                                             WTSCH
WTSCH
                                                                                                                                          170-
589.
590.
             160 STPS(1)=SBODY+SVERT
                                                                                                                             WTSCH
591.
592.
             170 CONTINUE
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C
C
C
        CCC
        CCC
                                                                                               WTSCH
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               WBASIC=C(13)=SBODY+C(14)=VBODY+C(15)
        CCC
               COMPUTE BODY SECONDARY STRUCTURE WEIGHT
               WSECST=C(23)*SBODY+C(80)*WWAIT(7)+C(169)
        CCC
               COMPUTE THRUST STRUCTURE WEIGHT
               WTHRST=C(168)=TTOT+C(163)
        CCC
               SUM BODY WEIGHT
               WBODY=WINFUT+WINOXT+WBASIC+WSECST+WTHRST
        000
               COMPUTE TPS INSULATION MEIGHT
               WINSUL=C(180)+STPS(1)+C(26)
               COMPUTE TPS COVER PANELS WEIGHT
                                                                                               MTSCH
MTSCH
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MTSCH
               WCOVER=C(181)+STPS(1)+C(27)
               SUM TPS WEIGHT
               WTPS=WIMSUL+MCOVER
        CCC
               COMPUTE LAUNCH EQUIPMENT HEIGHT
                                                                                               WTSCH
WTSCH
WTSCH
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WTSCH
               WLANCH=C(143)#WTO+C(144)
        000
               COMPUTE LANDING GEAR WEIGHT
               ₩L6=0.0
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IF(WGRDSS.GT.O.O.AND.C(182).GT.O.O)
1WLG=C(30)+WMAIT(7)++C(182)+C(31)
                                                                                                                                        WTSCH
WTSCH
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669.
671.
672.
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674.
675.
676.
677.
           000
                     COMPUTE DOCKING EQUIPMENT
                     WD0CK=C(147)+MMAIT(5)+C(148)
                     COMPUTE DEPLOYABLE AREO DEVICES
                     WOPLOY=C(145)=WMAIT(7)+C(146)
                     SUM LAUNCH AND RECOVERY GEAR
 680.
681.
682.
                                                                                                                                        MTSCH
MTSCH
MTSCH
MTSCH
                     WLRD=WLANCH+WLG+WDOCK+WDPLOY
                     COMPUTE CREW WEIGHT
                                                                                                                                        WTSCH
WTSCH
WTSCH
WTSCH
                     WPERS=C( 97 )+NCREW+C( 98 )
 686.
687.
688.
                     COMPUTE ENGINE MOUNT WEIGHT
688.
689.
696.
                                                                                                                                        WITSCH
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                     WENGAT=C(183)+TTOT+C(184)
          CCC
696.
691.
692.
693.
695.
696.
697.
698.
700.
700.
                     COMPUTE GIMBAL TORQUE
                     IF(NENGS.NE.O.O.AND.PCHAM.NE.O.O) TDEL=750.+(TTOT/NENGS/PCHAM)++
                    1 1.25
          CCC
                     COMPUTE GIMBAL SYSTEM WEIGHT
                    WSTAB=0.0
IF(TDEL.GT.O.O.AND.C(160).GT.O.0)
1WSTAB=NENGS+(C(28)+TDEL++C(160))+C(161)
          CCC
703.
704.
705.
                     COMPUTE SECONDARY ROCKET ENGINE WEIGHT
                     WENGS2=C(140)+TT0T2+C(141)
                     COMPUTE AIR BREATHING ENGINE WEIGHT
708.
709.
                     WABPR=C(210)=WWAIT(6)+C(211)
710.
711.
712.
713.
714.
715.
716.
717.
718.
719.
          C
C
C
                     COMPUTE AIR BREATHING NACELLES WEIGHT
                     WNACEL=C(36)+WABPR+C(37)
                     TEST-FOR AIR BREATHING FUEL TYPE IF LM2 GO AROUND JP-4 SYSTEM MEIGHT EQUATION
                                                                                                                                        WTSCH
WTSCH
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WTSCH
                     WBPUMP=0.0
WPRSYS=0.0
WDIST1=0.0
721.
722.
723.
                     IF (C(212).NE.O.O.OR.C(213).NE.O.O) 60 TO 180
                                                                                                                                                     180-
                     COMPUTE JP-4 FUEL PUMPS WEIGHT
723.
724.
725.
726.
727.
728.
729.
                                                                                                                                        WTSCH
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                     WBPUMP= C(149)+AMENGS+(1.75+.266+ANENGS)/1000.
                     COMPUTE JP-4 PRESSURE SYSTEM WEIGHT
                     WABFPS=0.0009+C(149)+ANENGS+ANTANK
          CCC
731.
732.
733.
734.
                     COMPUTE JP-4 FUEL DISTRIBUTION SYSTEM WEIGHT
                     WDIST1=ANENGS+C(191)+SORT(C(149))
          C
735.
736.
737.
738.
739.
740.
                                                                                                                                        WTSCH
WTSCH
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WTSCH
               180 CONTINUE
         CCC
                     COMPUTE ROCKET ENGINE WEIGHT
                   HENGS=0.0

IF(C(221).GT.0.0)

1WENGS=C(32)+TTOT+C(219)+TTOT+C(220)++C(221)+C(33)+NENGS+WENGAT
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750.
751.
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754.
755.
                                   COMPUTE ROCKET FUEL TANK WEIGHT NON-STRUCTURAL
                                    WFUTK=C(39)+VFUTK+C(40)
                                    COMPUTE ROCKET LOX TANK WEIGHT NON-STRUCTURAL
                                    WOXTK=C(41)-VOXTK+C(42)
                                    COMPUTE ROCKET SECONDARY FUEL TANK WEIGHT
                                   WFUTK2=C(170)+VFUTK2+C(136)
                                   COMPUTE ROCKET SECONDARY LOX TANK WEIGHT
 7558.
77559.
77662.
77662.
77667.
77777.
77777.
77777.
7777.
7777.
7777.
                                   WOXTK2=C(171)+V0XTK2+C(137)
                                    COMPUTE ROCKET PROPELLANT TANK INSULATION WEIGHT
                                   WINSTK=C(43)+SFUTK+C(77)+SDXTK+C(44)
                                   COMPUTE ROCKET FUEL SYSTEM WEIGHT
                                   WFUSYS=C(45)+TTOT+C(46)+LBODY+C(47)
                                   COMPUTE ROCKET LOX SYSTEM WEIGHT
                                   WOXSYS=C(48)+TTOT+C(49)+L800Y+C(50)
                  CCC
                                    COMPUTE ROCKET PRESSURE SYSTEM WEIGHT
                                   WPRSYS=C(51)=VFUTK+C(52)=VOXTK+C(187)
                                   TEST-FOR AIR BREATHING FUEL TYPE 1F LM2 GO AROUND JP-4 SYSTEM WEIGHT EQUATION
                                   GAL=0.0
MFUNCT=0.0
MD1ST2=0.0
MFCONT=0.0
WREFUL=0.0
MDRANS=0.0
  781.
782.
783.
786.
787.
788.
7890.
790.
791.
792.
795.
795.
796.
797.
798.
798.
                                    IF (C(212).NE.O.O.OR.C(213).NE.O.O) 60 TO 190
                                    COMPUTE JP-4 FUEL IN GALLONS
                                    GAL=WABFU/6.5
                                    COMPUTE JP-4 FUEL SYSTEM TANKS WEIGHT
                                    IF(ANTANK.ME.O.O) WFUNCT=C(189)+(GAL/ANTANK)++.6+ANTANK+C(190)
                                    COMPUTE JP-4 FUEL SYSTEM DISTRIBUTION WEIGHT
                                    WDIST2=.255+GAL++.7+ANTANK++.25
                                   COMPUTE JP-4 FUEL SYSTEM CONTROLS WEIGHT
802.
803.
804.
805.
806.
807.
810.
811.
812.
813.
813.
                                   WFCONT=.169+ANTANK+SQRT(GAL)
                                    COMPUTE JP-4 FUEL SYSTEM REFUEL SYSTEM WEIGHT
                                   WREFUL=ANTANK+(3.+.45+GAL++C13)
                                    COMPUTE JP-4 FUEL SYSTEM REFUEL SYSTEM WEIGH
                                    HDRAMS=. 159+64L++.45
                  CCC
                                    COMPUTE JP-4 FUEL TANK SEALING
                                   IF(ANTANK.NE.O.O) WSEAL=.045+ANTANK+(GAL/ANTANK)++.75
                                    SUM JP-4 FUEL SYSTEM WEIGHT
```

190-

| }
}
). | C | ABFSYS=WBPUMP+WDIST1+WDIST2+WFCDNT+WREFUL+WDRANS+WSEAL+WFUNCT
1-WABFFS | WTSC
WTSC |
|--------------|---|--|--------------|
| | ε | | WTSC |
|).
). | C | SUM JP FUEL SYSTEM WEIGHT LESS TANKS | WTSC |
| ; .
; . | c | WABFS=ABFSYS-WFUNCT | WTSC |
| | Ť | 190 CONTINUE | HTSC |
| '. '
}. | Ç | COMPUTE AIRFUEL TANK WEIGHT | WTSO |
|).
). | Č | WABFTK=C(212)*WABFU+C(213) +ABFSYS | WTS(|
| ١. | Ç | | WTSI |
| }.
}. | C | SUM PROPULSION SYSTEM WEIGHT | WTS(|
| i. | | WPROP=WENGS+WNACEL+WFUTK+WOXTK+WINSTK+WFUSYS+WOXSYS+WPRSYS+WENGS2+
1WFUTK2+WOXTK2+WABPR+WABFTK | MTS(|
| 7. | C | COMPUTE AREO SURFACE CONTROL WEIGHT | WTS(|
|).
). | C | WAERO=0.0 | HTS(|
| ١. | | IF(WWAIT(5),GT.O.O.AND.(LBODY+CSPAN).GT.O.O.AND.C(185).GT.O.O) 1WAERO=C(55)*(WWAIT(5)**.689*(LBODY+CSPAN)**.287)**C(185)+C(56) | WTS(|
| 2. | C | | WT5 |
| }.
 . | č | COMPUTE SEPARATION SYSTEM WEIGHT | WTS! |
| | Ī | IF(JUMP.EQ.O.O) WAUXT=C(153)+WTO+C(154)
IF(JUMP.EQ.1.O) WAUXT=C(153)+WPAYL+C(154) | WTS |
| ۲. | Ç | | WTS |
| }.
}. | C | COMPUTE ACS SYSTEM WEIGHT | MTS! |
|).
I. | | MACS=0.0
1F(WYO.GT.O.O.AND.C(155).GT.O.O) | MTS! |
| 2. | _ | 1WACS=C(156)+WWAIT(4)++C(155)+C(157) | #T5 |
| }.
†. | C | COMPUTE ACS PROPELLANT TANK WEIGHT | MTS |
| š.
Š. | C | WACSTK=C(164)+(WACSFO+WACRES)+C(165) | HTS: |
| 7.
3. | ç | SUM ORIENTATION CONTROLS WEIGHT | MTS: |
|).
). | ¢ | WORSUL=WSTAB+WACS+WAERO+WAUXT+WACSTK | MTS |
| i . | C | COMPUTE GUIDANCE AND NAVIGATION SYSTEM WEIGHT | MTS! |
|).
). | Č | MGNA4=C(68) | WTS |
| j . | Ç | | WTS |
|).
!. | Ç | COMPUTE INSTRUMENTATION SYSTEM WEIGHT | MTS
MTS |
| }.
}. | ε | WINST =C(69)+LBODY+C(70) | MIS! |
| ١. | C | COMPUTE COMMUNICATION SYSTEM WEIGHT | WTS! |
| } . | C | WCOMM=C(71)=NCREW+C(72) | HTS |
|).
 - | C | SUM AVIONICS SYSTEM | HTS: |
| 5.
5. | C | WAVIOC=WGNAV+WINST +WCOMM | WTS |
| | C | COMPUTE PRIME POWER SOURCE AND DISTRIBUTION | WTS |
| ;
; | č | MSORCE=C(62) * MMAIT(6) + C(64) | WTS |
| 2. | C | COMPUTE PRIME POWER SOURCE TANKAGE | MTS! |
| 3.
1. | č | BPOBTK=C(29)=MPOBFO+C(60) | WTS |
| 5. | č | | MTS! |
|).
7. | C | SUM ELECTRICAL POWER SYSTEMS | WTS |
| }.
}. | С | WPOWER=WSORCE+WPOWTK | WTS! |
| j.
I. | Č | COMPUTE HYDRAULIC/PNEUMATIC SYSTEM | WTS: |
| :
: | ٠ | HHYCAD=0.0 | WIS |

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CCC
                                        SUM POWER CONTROL AND DISTRIBUTION
                                                                                                                                                                                                                                                              WTSCH
WTSCH
WTSCH
                                       WPOWED=WHYCAD
                    CCC
                                                                                                                                                                                                                                                             WTSCH
WTSCH
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WTSCH
                                        COMPUTE PERSONNEL ACCOMODATIONS WEIGHT
                                        WPPROV=C: 74)+WWAIT(7)+C(75)+MCREW+C(76)
                    CCC
                                     WDRY=WSURF+WB0DY+WTPS+WLRD+WPR0P+WORSUL+WPOWCD+WGNAY+WINST +WCOMM+
1WPPROY +WPOWER
                                                                                                                                                                                                                                                              WTSCH
WTSCH
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WTSCH
                    CCC
                                       COMPUTE GROWTH AND CONTINGENCY
                                        CRAP = WDRY-WENGS-WABPR-C(141)
WCONT = C(96)+CRAP + C(162)
                    C
C
C
                                       SUM WEIGHT WEIGHT EMPTY
 915.
916.
917.
918.
919.
920.
921.
                                                                                                                                                                                                                                                              WTSCH
WTSCH
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WTSCH
                                        WEMPTY=WDRY+WCONT
                                        COMPUTE CARGO WEIGHT
                                        WCARGO=C(102)+NPASS+C(103)
                    CCC
923.
924.
9226.
9227.
9229.
9331.
933.
933.
933.
933.
934.
942.
942.
944.
                                        COMPUTE PASSENGER WEIGHT
                                                                                                                                                                                                                                                              WTSCH
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WTSCH
                                        WPASS=C(104)+MPASS+C(105)
                    CCC
                                       SUM PAYLDAD WEIGHT
                                       WPAYL=WPASS+WCARGD
                    CCC
                                       SUM OPERATING WEIGHT EMPTY
                                        WWET = WEMPTY+WRESID+WPERS+WPAYL+WRESRY
                                        SUM ZERD FUEL WEIGHT
                                        WZROFU= WWET+
                                                                                                           WFULOS+WOXLOS
+WACSFO
                                     1
2 + C(296)
                                                                                                                                                                     +WPOWFO+WOIL+WABFU+WFROST
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                    CCC
                                       SUM TAKEOFF WEIGHT
                                        WTO=WZROFU+WFUOX+WDECAY-WFUEL(1)-WOX(1)
                    C
C
C
 SUM GROSS WEIGHT
                                        WGROSS=WTO+WPREIG+WFUEL(1)+WOX(1)
                    CCC
                                        UPDATE WWAIT(1)
                                        WWAIT(1)=WGROSS -WPREIG
                    CCC
                                        GROSS WEIGHT LESS PAYLDAD
                                        WTABC=WGROSS-WPAYL
                    00000
                                        MISCELLANEOUS CONTROL STATEMENTS
                                        IF(NLISTO.NE.O) WRITE(6,MASS1)
IF(NLISTO.NE.O) WRITE(6,MASS2)
                                     IF (WGROSS.GT.20000000..AND.JUMP.EQ.1.OR.WGROSS.GT.10000000..AND.J
1UMP.EQ.0) GD TO 210
                                        RETURN
```

210

968. C 969. 970. 971. C 972. 973. C WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH WTSCH 210 WRITE(6, MASS1) WRITE(6, MASS2) CALL EXIT END

SUBRØUT I NE WTVØL

| FORTRAN
Symbol | MATH
Symbol | CODE DESCRIPTION | STORAGE
BLOCK LOC | SUBROUTINE USAGE
SUBR CODE VAR |
|-------------------|----------------|--|----------------------|--|
| вттот | • | O Total booster melght flem | /TAMP /(5 | S) SUMDUT I BITOT
TAMPER I BITOT
MIVOL O BITOT |
| C | | O Input array c(300) of vehicle sizing data | /CINPUT/(5 | PRINTW I C PRITEO I C PRITVA I C STORE M C WISCH I C WITCH O C |
| CTHRST | | M Vac. Thrust-to-meight ratio | /CIMPUT/(322 | PRITVA I CTHRST
STORE M CTHRST
WTSCH I CTHRST
WTVOL M CTHRST |
| ILAST | | W Print cycle flag 1 = print cycle 0 = not on a print cycle | t /WTVOL /C+ |) WTVOL W ILAST |
| ISP | | O Specific lapulse | /CIMPUT/(330 | PRWTSM 1 ISP
STORE M ISP
WTSCH I ISP
WTVOL O ISP |
| JUMP | | M Data flag D= orbiter l= booster | / Y P 9mUL\ |) FRENCH O JUMP PRINTM I JUMP PRITVA I JUMP PRWTSM M JUMP WTYOL M JUMP |
| TOT | | A Total orbiter thrust | /TAMP /(2 |) SUMOUT I OTTOT
TAMPER I OTTOT
WIVOL M DITOT |
| PRINTV | | S Subroutine to print vehicle volume data | /PRINTY/(\$ |) PRINTY E PRINTY
WIVOL S PRINTY |
| RINTH | | S Subroutine to print vehicle meight data | /PRINTW/(\$ |) PRINTU E PRINTU
MIVOL S PRINTU |
| PRWTSM | | S. Subroutine to print summary data | /PRWTSM/(\$ |) PRWTSM E PRWTSM
WTVDL S PRWTSM |
| RPAR | | W Weighting factor for updating range | /WT VOL /(+ |) WTVOL W RPAR |
| S C B | | A Working name for input c-array booster scaling coefficients | /ORBINY/(144 | FLYBER M SCB
STORE M SCB
SUMOUT I SCB
TAMPER I SCB
THRUST M SCB
VEHOF I SCB
WHOF M SCB |
| SE. | | A Array of synthesis iteration propulsion parameters | /512ING/(259 |) FLYBKP O SE PRITYA I SE SIZEAR I SE SUMOUT I SE TAMPER M SE THRUST I SE VEHDF M SE WISCH I SE WIYOU M SE |
| OLVE | | S Subroutine to drive meight and volume calculations (stsch) to convergence — an inner loop driver | /SOLVE /(\$ |) SOLVE E SOLVE
WIVOL S SOLVE |
| SPLAN | | I Body planform area | /VOLCAL/(14 | PROTHR I SPLAN
TAMPER I SPLAN
WITSCH O SPLAN
WITVOL I SPLAN |

| FORTRAN
Symbol | MATH
SYMBOL | CODE | DESCRIPTION | STORAG
BLOCK | LOC | SUBROUT
SUBR C | INE USAL |
|-------------------|----------------|------|--|---------------------|-----|---|--|
| SQ | | • | A synthesis data array (37,5) that contains the flyback data and some injection quantities | /S1ZING/(| 74) | PRITYA
RANGE
REUS
SIZE
SIZEMA
SIZIN
STAMPUT
TAMPER
THRUSZ
VEHDF | M Sa Sa Sa Sa Sa Sa Sa Sa Sa Sa Sa Sa Sa |
| SA | | 1 | A synthesis array (28) containing staging parameters and misc flags . | /\$121 # G/(| 46) | ENVPRM
FLYBKP
ITER8
RANGE
SIZEMR
SIZIN
SSSP
SUMOUT
TAMPAR
TAMPER
TROSZ
WEUDF | SY |
| TAMPER | | , s | Subroutine to interface weight and volume overlay with trajectory program overlay | /TAMPER/(\$ | ,) | TAMPER I | TAMPE
TAMPE |
| TB18 | | 0 | Stored booster value of cthrst | /ORBINY/C | 23) | STORE O | |
| 1827 | | I | Stored booster value of isp(i) | \0881W4\(| 41) | SIZEMR :
SSSP :
STORE !
SUMOUT !
TAMPER !
VEHDF !
WTVOL ! | 1827
1827
1827
1827
1827 |
| Γ 834 | | A | Stored booster value of mr(i) | /CRBINY/(| 53) | FLYBKP I
ITER8
SSSP F
STORE F
SUMOUT I
TAMPER I
VEHDF I
WIYOL F | TB34
TB34
TB34
TB34
TB34
TB34 |
| 1836 | | I | Stored booster value of memgs | /ORBINY/(| | STORE P
SUMOUT I
TAMPER I
THRUST I
WIVOL I | TB36
TB36
TB36 |
| 851 | | 0 | Stored booster value of whody | /ORBINY/(| | STORE # | TB51 |
| 856 | | Ħ | Stored booster value of agross | /ORB1MY/(- | | MTVOL F | |
| 018 | | n | Stored orbiter value of cthrst | /ORBINX/(| | STORE M
HTVOL M | |
| 027 | | i | Stared orbiter value of isp(i) | /ORBINX/(| | SIZEMR 1
SSSP I
STORE M
SUMOUT I | 1027
1027 |

A MOV 72 C 01-86

•



| ORTRAN
Symbol | MATH
Symbol | CODE | DESCRIPTION | STORAG
BLOCK | E
LOC | SUBRQU
SUBR | ILN | E USAGE |
|------------------|----------------|----------------------------------|-------------------------------------|--------------------|----------|--|----------------------------|--|
| | STABUL | | DEGOTT, 1701 | BLUCK | | 3 U B K | CUD | E VAN |
| 034 | | M Stored orbit | er value of er(1) | /ORBINX/(| 53) | ITER8
SSSP
STORE
TAMPER
VEHOF
WTVOL | # 0 # 1 0 # | T034
T034
T034
T034
T034
T034 |
| 036 | | 1 Stored orbito | er value of nengs | /0881 0 %/(| 60) | STORE
SUMOUT
TAMPER
THRUST
WT YOL | 1
1
1
1 | T036
T036
T036
T036 |
| 051 | | 0 Stared orbite | r value of vbody | /ORBINX/(| 102) | STORE
WT VOL | 0 | T051
T051 |
| 056 | | A Stored orbite | r value of mgross | /ORBINS/(| 107) | STORE
WT VOL | A | T056
T056 |
| 101 | | I Total stage o | ec. Thrust | /VOLCAL/(| 21) | PRITVA
STORE
WTSCH
WTVOL | I
I
R
I | TTOT
TTOT
TTOT
TTOT |
| WO | | W Thrust-to-mei | ght ratio | /HTVOL /(+ |) | MTVOL | w | THO |
| BODY | | 1 Total body va | lune | /CIMPUT/(| 391) | PRINTY
SOLVE
STORE
TAMPER
WTSCH
WTVOL | **** | ABODA
ABODA
ABODA
ABODA
ABODA |
| 80DY1 | | M Voody to - 1/ | 3 power | /VOLCAL/(| 25) | MTSCH
MT VOL | M M | VB00Y1 |
| BODY2 | | M Whody to - 2/ | 3 paper | /WOLCAL/(| 26) | WTSCH
WT VOL | Ħ | VB0DY2
VB0DY2 |
| 800 | | O Booster gross | melght . |)\ YGMUL\ | | PRINTU
Tamper
Ut vol | I
I
0 | ₩800
₩800 |
| F U O X | | l Weight of mai | n and secondary propellant | /WTCALC/(| | PRINTU
TAMPER
WTSCH
WTVOL | I
I
M
I | MFUOX
MFUOX
MFUOX
MFUOX |
| F U O X O | | M Propelient at | . Less fpr -orbiter | /TAMP /(| | SUMOUT
TAMPER
WT VOL | I
I | ₩F UQ XQ
₩F UQ XQ
₩F UQ XQ |
| GROSO | | M Orbiter gross | weight | /TAMP /(| | | 1
I | ₩6RDSD
₩6RQSD
₩6ROSD |
| GROSS | | I Gress lift-of | f seight | /CIMPUT/(| | PRWTSM
SOLVE
STORE
TAMPER
WTSCH | I
#
#
1
#
I | MGROSS
MGROSS
MGROSS
MGROSS
MGROSS
MGROSS
MGROSS |
| RES | | W Required orbi | ter gross meight | /HTVOL /(+ | 3 | MT VOL | u | MORER |
| OREO | | W Required orbit | ter propellant meight | /WTVOL /(+ |) | MT VOL | u | MPORES |
| SCH | | S Subroutine to
stages | calculate meight and valume of both | /WTSCH /(S | | MTSCH | Ē | WTSCH
WTSCH
WTSCH |
| AOL | | E Main program (
overlay(5,2) | for weight and volume calculations | VALADE VER | • | ĀT ADF | E | MIADF |

8 NOV 72 6.01-46

| FORTRAN MATH
Symbol Symbol |
|-------------------------------|
| SYMBOL SYMBOL |

```
PROGRAM MITVOL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    PTVOL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 MTVOL
MTVOL
SIZING
SIZING
                                         ç....
                                                                                                                                    PRIMARY SUBROUTINE FOR WEIGHT AND VOLUME SUBROUTINE
                                                                                  REAL MUB, MUD, ISPB, ISPO, IDVEL, MMB, MO COMMON /5121M6/ PARAMERERS

*TZ, VV(3), 9F(14), EROR, PZ

*SV(28), SQ(3)5, SE(11), TLAT, T

*PMASE I SIZING PARAMERERS

*MBD, MLDD, DEB, OMED, T

*BK1, BK2, BK3, BK4, I

*DK1, GK2, GK3, GK4, P

*AEXIT, TVACO MG
           ٩.
5.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              SIZING
SIZING
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                                         C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  SH(20),
                                                                                                                                                                                                                                                                                                                                                                                                                              PZ(5),
TLNG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                VĐ,
                                                                                PARAME
DWEB,
BK3,
OK3,
NO,
NNB,
MUB,
BSTG
   10.
                                         C
 11.
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13.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SIZING
SIZING
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OUBIEX
OM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ORBINX
ORBINX
ORBINX
ORBINX
                                                                           6, 1059, 1060, 1061, 1062, 1063, 1069, 1069, 1069, 1079, 1079, 1080, 1081, 1082, 1083, 81084

DIMEMSION SKB(30), SCB(300), TB4(6), TB20(10), TB27(6), TB34(6), 1
1848(10), TB49(10), TB50(10), TB57(6), BMSAVE(10)

COMMON/ORBINY/
1 TB1, TB2, TB3, TB4, TB5, TB6, TB7, TB8, TB9, TB10, TB11, TB12, TB13, TB14, 2
1815, TB16, TB17, TB18, TB15, TB6, TB7, TB8, TB9, TB10, TB11, TB12, TB13, TB14, 2
1815, TB16, TB17, TB18, TB15, TB20, TB21, 1822, 1823, 1824, 1825, 1826, 1827, 3
1824, 1829, 1830, 1831, 1832, TB33, TB34, TB35, T836, 1837, T838, T839, T840, 3
1841, TB42, TB43, TB44, TB45, TB46, TB47, TB48, TB49, TB50, TB51, TB52, TB53, 5
1854, T855, T856, T857, SKB, SCB, BMSAVE
6, TB59, TB60, TB61, TB62, TB62, TB65, TB66, TB67, TB68, TB69, TB70, TF671, T872, T873, T874, T875, T876, T877, T878, T879, T880, T881, T882, T883, T884

REAL ISP, K, LF, RR, NCREM, LB0DY, NPASS
REAL MEMSS
COMMON/CINPUT/
1AMENGS, ANTANK, ASRATO, ASMEEP, C(300), CBB0DY, CFUEL(6), 3CSPLAN CSVERT, CSMING, CTHRST, CTMST2, DEF(5), FXMOVS, 3CSPLAN CSVERT, CSMING, CTHRST, CTMST2, DEF(5), FXMOVS, 3CSPLAN CSVERT, CSMING, CTHRST, CTMST2, DEF(5), FXMOVS, 5MEMSS, MLISTO, NPASS, NML , PCHAM, 3C, RHOFU, RHOFU, ARROFU, CAURALLY ABODY, CROOT, CSPAN , CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GSPAN, CAURALLY ABODY, CROOT, CSPAN, CTIP, GAL, GAL, GAL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    UH
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29.
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ORBINY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ORBINY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ORBINY
UH
334444444444455555555555666666666677
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    UH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ĖИ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 UH
CINPUT
CINPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CLMPHT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CIMPUT
CIMPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CIMPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CINPUT
CINPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CIMPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CIMPUT
                                                                                   HNDS WARDS
TYTTAIL VBODY MGROSS
COMMON/VOLCAL/BBODY, CROOT
2MBDOY LBODY RTOD
3SPLAN STPS(1), SVERT
4TTOT TTOTS
TYOTAL
SVEREW VFUTK VFUTK2
4VOXTK2 VPROP VSTRUC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CIMPUT
VOLCAL
VOLCAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                , GSPAN
, SOXTK
, TROOT
, VCARGO
, VOXTK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  , GAL
, SHORZ
, TDEL
, VBODYZ
                                                                                                                                                                                                                                                                                                                         , CSPAN
                                                                                                                                                                                                                                                                                                                                                                                                           CTIP
                                                                                                                                                                                                                                                                                                                                                                                                     SFUTK
SXPOS
VBODY1
                                                                                                                                                                                                                                                                                                                              SFAIR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                VOLCAL
VOLCAL
VOLCAL
WICALC
WICALC
WICALC
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WICALC
                                                                                                                                                                                                                                                                                                                           , SWING
                                                                                                                                                                                                                                                                                                                           , VINSTR
                                                                                                                                                                                                                                                                                                                                                                                                          VLGBAY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       VOTHER
                                                                                     GONTRE PAPROP
COMPONINT CALCY
IMACS , MACSFO
SMEDIATE , MCARGO
SMENGAT , MENGS
SMEDIATE , MENGS
SMEDIATE , MENGS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WABPR
WBASIC
WOECAY
WELCAD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             , WACRES
, WBODY
, WDIST1
, WEMPTY
, WFROST
, WFURES
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| 76. | c | | WTVOL | |
|--|----------|---|----------|-------------|
| ii. | • | COMMON/TAMP/WGROSO,OTTOT,WFUQXO,TBTO,BTTOT | MT VOL | |
| 78. | | COMMON/JUMPY/ JUMP, WBIG, WBOD | CKOUT | |
| 79. | | CARRONITRICTI | CKOUT | |
| 80. | | + FVACO, FSLO, FVACLO, FVACS, | CKOUT | |
| 81. | | FVACO, FSLO, FVACLO, FVACS,
FVACB, FSLB, FSLLO, FSLS | CKOUT | |
| 82. | č | CHECK PRINT FLAG | MIAOF | |
| 83.
84. | č | CHECK PRIMI PLMS | MIAOF | |
| 85. | • | BTWTQL=SW(18)+.5 ' | MTVOL | |
| 86. | | BMX = SE(6) | MTVOL | |
| 87. | | WOREQ = \$Q(10,1)
WPOREQ = \$Q(13,1) | MTVOL | |
| 88. | | WPOREQ = SQ(13,1) | MTVOL | |
| 89. | | GMREQ= 50(16,1) | MIVOL | |
| 90.
91. | ε | IF(SW(3).6E.1.) 60 TO 40 | MT VOL | 40-7 |
| 92. | č | FIRST PASS LOGIC | MTVOL | |
| 93. | Č | | WTVOL | |
| 94. | _ | 50(15,2)=1. | MTVDL | |
| 95. | Č | MARAL | MIVOL | |
| 96. | C | NORMAL ENTRY POINT - INITALIZE VARIABLES | MIYOL | |
| 97. | | | MTVOL | |
| 98.
99.
100. | 40 | CONTINUE | WTVOL | - |
| 99. | | SH(3)=SH(3)+1. | MIAOF | |
| 100. | | 818=.0005
808=.00025 | WT VOL | |
| 102. | | ILAST=0 | MT VOL | |
| 103 | | EROR = 0.1 | HTVOL | |
| 104. | | GUS = 0. | MTVOL | |
| 109.
105.
106. | | ACEL=0. | MTVOL | |
| 106. | | ACNT=0. | MTVOL | L |
| 107. | 101 | CONTINUE | WTVOL | |
| 108. | | ACHT=ACHT+1. | MTVOL | |
| 109. | С | CALL ORBEAL FIXED THRUST-TO-WEIGHT | MINOL | |
| 110. | L | 15P(3) = T027(3) | MI AOF | |
| 112 | | 10RP = 0 | MTVOL | |
| 110.
111.
112.
113.
114.
115. | | JURP = 0
CALL WISCH | MTVOL | |
| 114. | | CALL SOLVE | MT VOL . | |
| 115. | | ABODA1 = ABODA | MIVOL | |
| 110. | | WGROSO=WGROSS | MINOF | |
| 117. | | WFUOXO=WFUOX
OTTOT=TTOT | MT VOL | |
| 118. | | OSPLAN = SPLAN | MIVOL | |
| 120. | | 60 TO 291 | WTVOL | 291- |
| 121 | 105 | CONTINUE | MINOL | |
| 121.
122. | • • • • | CALL BOOCAL | MTVOL | |
| 123. | C | | MTVDL | |
| 124. | Ç | CHECK CONSTANT (T/W)L.O. FLAG | MINOL | |
| 125. | ε | *** **** ** * * * * * * * * * * * * * | MTVOL | |
| 126. | С | IF(SE(3).E0.0.) 60 TO 200 | WT VOL | 200 |
| 127. | Č | FIXED THRUST-TO-WEIGHT | MINOL | |
| 128.
129.
130. | 197 | SCB(129) = 0. | WTVOL | |
| 130. | • | C(129) = 0. | MTVOL | 111 |
| 131. | | CTHRST = CTHRST + SE(1)/ TB27(2) | MTVOL | 11 1 |
| 132. | | TB18 = CTMRST | MTVOL | la.a |
| 131.
132.
133.
134. | r | GO TO 210 | MT VOL | 210- |
| | <u> </u> | FIXED THRUST | MIAOF | [14 |
| 135.
136. | 200 | CTHRST = 0. | MTVOL | |
| 136. | | TB18 = 0.
TBT0 = SW(6) + TB36/T 036 | WT VOL | i |
| 138 | | SCB(129) = OTTOT+TBTO/TB36 | MIANC | 1 1 1 1 |
| 138. | | C(129) = SCB(129) | WTVOL | 111 |
| 140 | 210 | ISP(3) = 1827(3) | MTVOL | ┝━┛╽╏ |
| 140. | 410 | 15P(3) = (627(3) | MITTOL | 1 |
| 142. | | CALL MISCH | MIVOL | { |
| 142 | | CALL SOLVE | WTVOL | 1 |
| 194. | | BITOT = TTOT | WTVOL | |
| 145. | | ABODAS = ABODA | MTVOL | |
| 146. | 269 | TB51= V80DY2 | MIVOL |]]] |
| 194.
195.
196.
197.
198. | | T051 = V600Y1
TB56 = WGROSS | MIVOL | 1 1 |
| | | .070 - MGMUJJ | MAAOL | · |
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| 49.
50. | WB00 = WGR0SS-T056
T056 = WGR0S0 | MI AOF | 1 11 |
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| 51. 291
52.
53. | CONTINUE IF(ILAST.NE.1 .AND. SW(16) . EQ. 0.) GO TO 292 CALL PRINTW CALL PRINTY | CKONT
CKONT
MI AOF
MI AOF | 292 |
| 55.
56. 292
57.
58.
59. | CALL PRWTSM CONTINUE IFJUMP.EQ.1) GO TO 300 CALL ORBSUM CALL ORBSTO | MIAOF
MIAOF
MIAOF
CKONI | 300 |
| 60.
61. 300 | GO TO 195
CONTINUE
C(3) = SCB(3) | WTVOL
WTVOL | 195 |
| 62.
63.
64.
65.
66. | C(5) = SCB(5)
C(7) = SCB(7)
C(146) = SCB(146)
C(31) = SCB(31) | MI AOF
MI AOF | |
| 67.
68.
69.
70. | C(56) = SCB(56)
C(129) = SCB(129)
C(21)=SCB(211)
C(67) = SCB(67) | MIAOF
MIAOF
MIAOF | |
| 71. C
72. C
73. C | CHECK CONST. T/M-LG FLAG | MIAOF
MIAOF
MIAOF | 400-7 |
| 177. | CTHRST = CTHRST * TB27(2)/ \$E(1) CALL BOOSUM CALL BOOSTO | MIAOF
MIAOF | |
| 78.
79.
80.
81
82. | CALL TAMPER(1) TWO = OTTOTYTO56 WRITE (6,10G0) T034(3),T056,OTTOT,TWO,TB34(3),TB56,QP(1),SV(13) IF(SE(3) EQ.1.) GO TO 500 IF(ACNT.GE.SW(19)) GO TO 500 | MIAOF
MIAOF
MIAOF
MIAOF | 500 |
| .83. C *4
84. C
85.
86
87. | SPECIFIED LIFTOFF T/W *** IF(SW(2).E0.1.) BTWTOL=SW(18) IF(ABS(SV(13)-SW(17)) .LE. BTWTOL) GO TO 500 TO18 = TO18/SV(13) * SW(17) | MIAOF
MIAOF
MIAOF
MIAOF | 500- |
| 90. | GO TO 101
CONTINUE
ACNT=0. | MI VOL | 101 |
| 191.
192.
193. C **
194. C | ACEL=ACEL+1. IF(GWREQ.LE.O.) GO TO 800 THIS LOOP ADJUSTS PAYLOAD MEIGHT TO OBTAIN SPECIFIED GROSS LIFTOFF MEIGHT *** DIFF=GWREQ-T856 | M1 AOF
M1 AOF
M1 AOF
M1 AOF | 800- |
| 96.
97.
98. | TOH=DIFF/GMREO TF(ABS(TOM) .LT.BIB) GO TO 509 IF(ACEL.GT.1.) GO TO 502 SLOPE=-21. 1 | MIAOF
MIAOF | 504 |
| 100.
101. | IF(SW(3) .GT.1OR. GUS.GT.O.) SLOPE=SW(8)
GO TO 505
SLOPE = (DIFF - SDIFF)/(SCO(103) - SAPAY) | MT VOL | 505 |
| 03. 509 | CONTINUE WRITE(6,1001) SCO(103),DIFF,SLOPE SW(8) = SLOPE | MI VOL | |
| 05.
06.
07.
08. | SDIFF = DIFF
SAPAY = SCO(103)
SCO(103) = SCO(103) - DIFF/SLOPE
IF(ACEL_ST.6.) GO TO 503 | MI VOL
MI VOL | 503-7 |
| 10.
11. 503
12. | 60 TO 101
B WRITE(6, 1002)
GO TO 600 | MIAOF
MIAOF | 600-1101- |
| | WRITE(6,1001) SCO(103), DIFF, SW(B) TOM = DIFF/GWRED WRITE(6,1003) TOM GO TO 660 | MI AOF
MI AOF
MI AOF | 600 |
| |) CONTINUE
IF(SE(3).E0.1 .OR.SW(19).GT.O.) GD TO 600 | MT VOL | 600 |

| 291. GO TO 705 292. 702 S = (DW -SDM)/(TB34(3)-S 293. 705 WRITE(6,1006) DM ,S 294. SQ(11,1) = S 295. SD M = D M 296. SMR = TB34(3) 297. TB34(3) = TB34(3) - DM /S 298. RPAR=SQ(19,3) 299. IF(RPAR.GT.100.)SCB(214)=SC 300. T034(3)= TD34(3)-SAR / TB34 301. IF(GUS.GT.6.) GO TO 703 302. GUS = GUS + 1. 303. GO TO 101 304. 703 WRITE(6,1002) 305. 704 WRITE(6,1002) 306. 900 CONTINUE 307. IF(SW(2).EQ.1.) ILAST=1 308. IF(ILAST.EQ.1) GO TO 101 309. 950 CONTINUE 301. CALL TAMPER(2) 311. RETURN 312. 1000 FORMAT (15HOORBITER MU = F 313. 1= F9.0,10H T/W = F9.6/ 314. 2 15H BOOSTER MU = F 315. 3= F9.0,10H T/W = F9.6/ 316. 1001 FORMAT(5X,11HPAYLOAD = F10 117. IE = F12.4///) 318. 1002 FORMAT(5X,15HCONVERG ERR = GO TO TO TO TO TO TO TO TO TO TO TO TO TO | B(214)+SE(5)+(TB34(3)-SAR)/RPAR | 11
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|--|---------------------------------|--|--|-----------------|-----|
| 293. 705 WRITE(6,1006) DM ,S 294. SQ(11,1) = S 295. SD | B(214)+SE(5)+(TB34(3)-SAR)/RPAR | 10
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| 294. SQ(11,1) = S 295. SD M = D M 296. SMR = TB34(3) = TB34(3) - DM /S 298. RPAR=SQ(19,3) = TB34(3) - DM /S 298. RPAR=SQ(19,3) 299. IF(RPAR.GT.100.)SCB(214)=SC 300. T034(3)= T034(3)=SMR / TB34 301. IF(GUS.GT.6.) GD T0 T03 302. GUS = GUS + 1. 303. GO T0 101 304. 703 WRITE(6,1002) 305. 704 WRITE(6,1002) 306. 704 WRITE(6,1006) CM,SQ(11,1) 307. IF(SW(2).EQ.1.) ILAST=1 308. IF(SW(2).EQ.1.) ILAST=1 309. 950 CONTINUE 310. CALL TAMPER(2) 311. RETURN 312. 1000 FORMAT (1SHOORBITER MU = F 313. 1= F9.0,10M T/W = F9.6/ 314. 2 ISM BOOSTER MU = F 315. 3 = F9.0,10M T/W = F9.6/ 316. 1001 FORMAT(SX,11MPAYLOAD = F10 317. 1E = F12.4///) 318. 1002 FORMAT(SX,11MPAYLOAD = F10 319. 1003 FORMAT(SX,11MPAYLOAD = F10 319. 1003 FORMAT(SX,15HCONVERG ERR = F12.4///) 319. 1003 FORMAT(SX,5HCONVERG ERR = F12.4///) 320. 1004 FORMAT(SX,5HCONVERG ERR = F12.4///) 321. 1005 FORMAT(SX,5HCONVERG ERR = F12.4///) 322. 1006 FORMAT(SX,5HORDW = F8.5, SM 3221. 1005 FORMAT(SX,5HORDW = FR.5, SM 3221. 1005 FORMAT(SX,5HORDW = FR.5, SM 3221. 1006 FORMAT(SX,5HORDW = FR.5, SM 3221. 1006 FORMAT(SX,5HORDW = FR.5, SM 3221. 1006 FORMAT(SX,5HORDW = FR.5, SM 3222. 1006 FORMAT(SX,5HORDW = FR.5, SM | | 16
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| 295. SD M = D M 296. SMR = TB34(3) 297. TB34(3) = TB34(3) - DM /5 298. RPAR=SQ(19,3) 299. IF(RPAR.GT.100.)SCB(214)=SC 300. T034(3)= T034(3)=SMR / TB34 301. IF(GUS.GT.6.) GO TO TO3 302. GUS = GUS + 1. 303. GO TO 101 304. 703 WRITE(6,1002) 305. 704 WRITE(6,1002) 306. 900 CONTINUE 307. IF(SW(2).EQ.1.) ILAST=1 308. IF(ILAST.EQ.1) GO TO 101 309. 950 CONTINUE 311. RETURN 310. CALL TAMPER(2) 311. RETURN 312. 1000 FORMAT (15HOORBITER MU = F 313. 1= F9.0,10M T/M = F9.6/ 314. 2 ISM BOOSTER MU = F 315. 3= F9.0,10M T/M = F9.6/ 316. 1001 FORMAT(SX,11MPAYLOAD = F10 317. 1E = F12.4///) 318. 1002 FORMAT(SX,11MPAYLOAD = F10 319. 1003 FORMAT(SX,15HOONERG ERR = F12.4///) 319. 1004 FORMAT(SX,15HOONERG ERR = S12.0 1004 FORMAT(SX,15HOONERG ERR = S12.0 1004 FORMAT(SX,15HOONERG ERR = S12.0 1004 FORMAT(SX,15HOONERG ERR = S12.0 1004 FORMAT(SX,15HOONERG ERR = S12.0 1004 FORMAT(SX,15HOONERG ERR = S12.0 1004 FORMAT(SX,15HOONERG ERR = S12.0 1004 FORMAT(SX,5HOONERG ERR = S12.0 1004 FORMAT(SX,5HOONERG ERR = S12.0 1006 | | ###################################### | VOL
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| 1834(3) = 1834(3) - DM /S 1898. RPAR=SQ(19,3) 1999. IF(RPAR.GY.100.)SCB(214)=SC 1000. T034(3)= T034(3)=KMR / T834 101. IF(GUS.GY.6.) GD TO 703 102. GUS = GUS + 1. 103. GO TO 101 104. 703 WRITE(6,1002) 105. 704 WRITE(6,1002) 106. 900 CONTINUE 107. IF(SW(2).EQ.1.) ILAST=1 108. IF(ILAST.EQ.1) GO TO 101 109. 950 CONTINUE 110. CALL TAMPER(2) 111. RETURN 112. 1000 FORMAT (15HOORBITER MU = F 113. 1= F9.0,10M T/M = F9.6/ 114. 2 115. 3= F9.0,10M T/M = F9.6/ 116. 1001 FORMAT(5X,11HPAYLOAD = F10 117. 16 = F12.4///) 118. 1002 FORMAT(5X,15HCDNVERG ERR = F12.4///) 119. 1003 FORMAT(5X,15HCDNVERG ERR = 120. 1004 FORMAT(5X,15HCDNVERG ERR = 120. 1004 FORMAT(5X,15HCDNVERG ERR = 120. 1004 FORMAT(5X,15HCDNVERG ERR = 120. 1004 FORMAT(5X,15HCDNVERG ERR = 120. 1004 FORMAT(5X,15HCDNVERG ERR = 120. 1004 FORMAT(5X,15HCDNVERG ERR = 120. 1004 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDNCM W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X,5HCDR W TO IFF = 120. 1005 FORMAT(5X, | | 16
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| 298. RPAR=\$G(19,3) 299. IF(RPAR,GY.100.)\$CB(214)=\$C 300. T034(3)= T034(3)=\$MR / T834 301. IF(GUS.GT.6.) GO TO 703 302. GUS = GUS + 1. 303. GO TO 101 304. 703 WRITE(6,1002) 305. 704 WRITE(6,1006) DW,\$G(11,1) 306. 900 CONTINUE 307. IF(SW(2).EQ.1.) ILAST=1 308. IF(ILAST.EQ.1) GO TO 101 309. 950 CONTINUE 310. CALL TAMPER(2) 311. RETURN 312. 1000 FORMAT (15HOORBITER MU = F 313. 1= F9.0,10H T/M = F9.6/ 314. 2 315. 3= F9.0,10H T/M = F9.6/ 315. 3= F9.0,10H T/M = F9.6/ 316. 1001 FORMAT(5X,11HPAYLOAD = F10 317. 1E = F12.4///) 318. 1002 FORMAT(5X,36H==================================== | | WT
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| 101. | | 91
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| 103. GO TO 101 104. 703 WRITE(6,1002) 05. 704 WRITE(6,1006) DW, SQ(11,1) 06. 900 CONTINUE 07. IF(SW(2).EQ.1.) ILAST=1 1F(ILAST.EQ.1) GO TO 101 109. 950 CONTINUE 110. CALL TAMPER(2) 111. RETURN 12. 1000 FORMAT (15HODRBITER MU = F 113. 1= F9.0,10H T/M = F9.6/ 114. 2 15M BOOSTER MU = F 115. 3= F9.0,10H T/M = F9.6/ 116. 1001 FORMAT(5x,11HPAYLOAD = F10 117. 1E = F12.4///) 118. 1002 FORMAT(5x,36H=*** ITERATIO 119. 1003 FORMAT(5x,36H=*** ITERATIO 119. 1003 FORMAT(5x,15HCDNYERG ERR = 1003 FORMAT(5x,15HCDNYERG ERR = 1004 FORMAT(5x,15HCDNYERG ERR = 1005 FORMAT(5x,15HCDNYERG ERR = 1006 FORMAT(5x,15HCDNYERG ERR = 1006 FORMAT(5x,15HCDNYERG ERR = 1006 FORMAT(5x,15HCDNYERG ERR = 1006 FORMAT(5x,15HCDNYERG ERR = 1006 FORMAT(5x,15HCDNYERG ERR = 1006 FORMAT(5x,25HORB WT DIFF = 1006 FORMAT(5x,25HORB PROPELLANT | | TW
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| 04. 703 WRITE(6,1002) 05. 704 WRITE(6,1006) DW, SQ(11,1) 06. 900 CONTINUE 17. 1F(SW(2).EQ.1.) ILAST=1 10. 1F(SW(2).EQ.1.) ED TQ 101 10. CALL TAMPER(2) 11. RETURN 12. 1000 FORMAT (15HOORBITER MU = F 13. 1= F9.0,10M T/M = F9.6/ 14. 2 15W BOOSTER MU = F 15. 3= F9.0,10M T/M = F9.6/ 16. 1001 FORMAT(5X,11HPAYLOAD = F10 17. 1E = F12.4///) 18. 1002 FORMAT(5X,36M++++ ITERATIO 19. 1003 FORMAT(5X,15HCDNVERG ERR = 120. 1004 FORMAT(5X,15HCDNVERG ERR = 120. 1004 FORMAT(5X,16HORB WI DIFF = 120. 1005 FORMAT(5X,16HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB WI DIFF = 120. 1006 FORMAT(5X,5HORB PROPELLANT | | WT | | 11 | 101 |
| 05. 764 WRITE(6,1006) DW, SQ(11,1) 06. 900 CONTINUE 07. IF(SW(2).EQ.1.) ILAST=1 08. IF(ILAST.EQ.1) SO TO 101 09. 950 CONTINUE 110. CALL TAMPER(2) 111. RETURN 112. 1000 FORMAT (15HODRBITER MU = F 113. 1= F9.0,10M T/M = F9.6/ 114. 2 15M BODSTER MU = F 115. 3= F9.0,10M T/M = F9.6/ 116. 1001 FORMAT(5X,11HPAYLOAD = F10 117. 1E = F12.4///) 118. 1002 FORMAT(5X,15HCDNYERG ERR = F12.4///) 119. 1003 FORMAT(5X,15HCDNYERG ERR = F12.4///) 120. 1004 FORMAT(5X,15HCDNYERG ERR = F12.4///) 120. 1005 FORMAT(5X,15HCDNYERG ERR = F12.4///) 120. 1006 FORMAT(5X,15HCDNYERG ERR = F12.4////) 120. 1006 FORMAT(5X,15HCDNYERG ERR = F12.4//////////////////////////////////// | | | VOL - | I | 1 |
| 06. 900 CONTINUE 1F(SM(2).EQ.1.) LLAST=1 108. IF(LLAST.EQ.1) GO TO 101 109. 950 CONTINUE 100. CALL TAMPER(2) 111. RETURN 112. 1000 FORMAT (15HOORBITER MU = F 113. 1= F9.0,10H T/M = F9.6) 114. 2 15M BOOSTER MU = F 115. 3= F9.0,10H T/M = F9.6) 116. 1001 FORMAT(5X,11HPAYLOAD = F10 117. 1E = F12.47//) 118. 1002 FORMAT(5X,36H==================================== | | ĽT | VOL - | | 1 |
| 1F(SM(2).EQ.1.) \$LAST=1 108. | | | VOL | | |
| 109. 950 CONTINUE CALL TAMPER(2) 111. RETURN 112. 1000 FORMAT (15HODRBITER MU = F 113. 1= F9.0, 10H T/M = F9.6/ 114. 2 15H BODSTER MU = F 115. 3= F9.0, 10H T/M = F9.6/ 116. 1001 FORMAT(5X, 11HPAYLOAD = F10 117. 1E = F12.4///) 118. 1002 FORMAT(5X, 36H+++++ ITERATIO 119. 1003 FORMAT(5X, 15HCDNYERG ERR = 1 120. 1004 FORMAT(5X, 16HDRB MT DIFF = 1 121. 1005 FORMAT(5X, 16HDRB MT DIFF = 1 122. 1006 FORMAT(5X, 25HDRB PROPELLANT | | WT | AOF | | |
| 110. CÁLL TAMPER(2) 111. RETURM 112. 1000 FORMAT (15MODRBITER MU = F 113. 1= F9.0,10M T/M = F9.6/ 114. 2 15M BOOSTER MU = F 115. 3= F9.0,10M T/M = F9.6) 116. 1001 FORMAT(5X,11MPAYLOAD = F10 117. 1E = F12.4///) 118. 1002 FORMAT(5X,36M==== ITERATIO 119. 1003 FORMAT(5X,36M==== ITERATIO 119. 1003 FORMAT(5X,5MOME ERR = E 120. 1004 FORMAT(5X,16MOME MT DIFF = E 121. 1005 FORMAT(5X,5MOME MT DIFF = E 122. 1006 FORMAT(5X,5MOME MT DIFF = E 122. 1006 FORMAT(5X,5MOME PROPELLANT | | | VOL 1 | 01 | |
| 100 FORMAT (15HOURBITER MU = F 113. 1 = F9.0,10H T/M = F9.6/ 114. 2 15H BOOSTER MU = F 115. 3 = F9.0,10H T/M = F9.6) 116. 1001 FORMAT(5X,11HPAYLOAD = F10 117. 1E = F12.47//) 118. 1002 FORMAT(5X,36H==================================== | | MT | VOL | | |
| 113. 1= F9.0,10H T/M = F9.6/ 114. 2 15M BOOSTER MU = F 115. 3= F9.0,10M T/M = F9.6) 116. 1001 FORMATISX,11HPAYLOAD = F10 117. 1E = F12.4///) 118. 1002 FORMATISX,36M+*** ITERATIO 119. 1003 FORMATISX,36M+*** ITERATIO 119. 1003 FORMATISX,35MDMU = F8.5, 5M 120. 1004 FORMATISX,16MDMB WI DIFF = 121. 1005 FORMATISX,16MDMB WI DIFF = 122. 1006 FORMATISX,25MDMB PROPELLANT | 8.5,13H WEIGHT = F9.0,13H | THRUST WT | VOL | | |
| 115. 3= F9.0,10M T/M = F9.6) 116. 1001 FORMAT(5X,11MPAYLOAD = F10 117. 1E = F12.47//) 118. 1002 FORMAT(5X,36M==================================== | • | ₩T | AOL | | |
| 116. 1001 FORMAT(5X,11MPAYLOAD = F10 117. 1E = F12.4///) 118. 1002 FORMAT(5X,36M+++++ ITERATIO 119. 1003 FORMAT(5X,15MCONVERG ERR = 1 120. 1004 FORMAT(5X,15MCOR WI DIFF = 1 121. 1005 FORMAT(5X,15MCOR WI DIFF = 1 122. 1006 FORMAT(5X,25MCOR POPELLANT | 8.5,13H WEIGHT = F9.0,13H | | AOF | | |
| 117. E = F12.4///) 118. 1002 FORMAT(5X,36H===== ITERATIO 119. 1003 FORMAT(5X,15HCDAVERG ERR = 120. 1004 FORMAT(6X,5HDRU = F8.5,5H 121. 1005 FORMAT(5X,16HDRB WT D1FF = 122. 1006 FORMAT(5X,25HDRB PROPELLANT | .2.5%.14HLO WT DIFF = F12.2.5% | | | | |
| 119. 1003 FORMAT(5%,15MCDAYERG ERR = 120. 1004 FORMAT(8%,5MDM) = F8.5, 5M | • • | ₩ T | AOT | | |
| 120. 1004 FORMAT(8% SHORD = FR.5 SH
121. 1005 FORMAT(SX,16HORB WT DIFF =
122. 1006 FORMAT(SX,25HORB PROPELLANT
123. END | F10.6///) | üt | VOL | | |
| 22. 1006 FORMAT(5X,25HORB PROPELLANT) 123. END | x = F8.4, 8H DTWT = F9.6 /) |) U T | AOF | | |
| 23. END | WT DIFF = F10.1.5% 8MSLOPE = F | :10.1//) UT | VOL | | |
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Section 1 POWELLS METHOD

The purpose of Subroutine POWELL is to find the values of N parameters, given by the vector—say,

$$\overline{Z} = (z_1, z_2, \ldots, z_N)$$
 (1.1)

so that the value of a function of these parameters—say, $F(\overline{Z})$ —is a minimum subject to constraints on the parameters of the form,

$$e_{i} \le z_{i} \le h_{i}, i=1, 2, ..., N$$
 (1.2)

The inequality constraints on the parameters (Equation 1.1) are handled by the BOX TRANSFORMATION where a change of variable is made from the z_i to a new set of parameters—say,

$$\overline{X} = (x_1, x_2, \ldots, x_N)$$

by the formula,

$$x_i = ARCSIN \left\{ \sqrt{(z_i - e_i)/(h_i - e_i)} \right\}$$
 (1.3)

Subroutine POWELL uses the x_i as a new set of independent parameters which have no inequality constraints imposed upon them. In terms of \overline{X} -space, the algorithm minimizes a function $f(\overline{X})$ related to $F(\overline{Z})$ by the equation:

$$f(\overline{X}) = F(\overline{Z}(\overline{X}))$$

1617

where Z(X) is defined by the inverse transformation,

$$z_1 = c_1 + (h_1 - e_1) \sin^2 x_1$$
 (1.4)

1. 1 BASIC ALGORITHM

The basic procedure is as follows (Reference 2):

1. Choose a best known approximation to the minimum of f-say, \overline{X}_0 .

Let ϵ_1 , ϵ_2 , ..., ϵ_N be unit vectors in the coordinate directions; then for $r=1, 2, \ldots, N$ calculate λ_r so that $f(\overline{X}_r)$ is a minimum where \overline{X}_r is defined by

$$\overline{X}_{r} = \overline{X}_{r-1} + \lambda_{r} \overline{\varepsilon}_{r}$$
 (1.5)

2. When \overline{X}_N is determined, find a λ_c so that $f(\overline{X}_N + \lambda_c \overline{\epsilon}_{N+1})$ is a minimum, where $\overline{\epsilon}_{N+1}$ is the unit vector in the combined direction:

$$(\overline{X}_N - \overline{X}_o)$$
.

- 3. Rotate the N+1 vectors, $\overline{\epsilon}_1$, $\overline{\epsilon}_2$, ..., $\overline{\epsilon}_N$, $\overline{\epsilon}_{N+1}$, by replacing $\overline{\epsilon}_r$ by $\overline{\epsilon}_{r+1}$ for $r=1, 2, 3, \ldots, N$.
- 4. Replace \overline{X}_0 by $\overline{\epsilon}_{N+1} + \lambda_c \overline{\epsilon}_{N+1}$ and return to Step 1.

The sequence of Steps 1 through 4 will be called a major iteration.

As indicated by the above steps, the procedure requires N+1 minimizations per major iteration.

1.2 THE MINIMIZATION ALGORITHM

The minimization algorithm employed in Subroutine POWELL uses an accelerated linear search until a set of three points which define a concave upward curve is achieved. It then uses these three points to initiate a quadratic search for the minimum.



In general, assume we are given a point \overline{X}_0 in X-space and a unit vector $\overline{\epsilon}$ along which the minimization is to take place;

$$\bar{\epsilon} = (u_1, u_2, \dots, u_N) \text{ with } |\bar{\epsilon}| = 1$$

Associated with each independent parameter, x;, is a nominal step sizesay, s;.

Now, define k, by

$$k_{\bar{\epsilon}} = \left[\sum_{i=1}^{N} \left(\frac{u_i}{s_i}\right)^2\right]^{-\frac{1}{2}}$$
(1.6)

Now the step taken along \(\varepsilon \) on the accelerated linear search portion of the minimization algorithm is a function of:

- $p = \begin{cases} number of previous steps taken along \overline{\epsilon}. \end{cases}$ (including the
- 2. $k_{\overline{\epsilon}}$ as defined above. 3. $q = \{ \text{number of the current major iteration} \}$.

Now, calling the current step $S(p, k_{\overline{e}}, q)$, we have

$$S(p, k_{\bar{\epsilon}}, q) = 2^{p-1} (k_{\bar{\epsilon}})/q$$
 (1.7)

(See Appendix A)

The process of stepping along $\bar{\epsilon}$ is from the current initial point \bar{X}_0 ; each new step being twice the previous step.

Now, if the accelerated linear search is in a descent direction, then the search continues until a point \overline{X}_{p} is found so that

$$\overline{X}_{p} > X_{p-1} (p>1)$$
 (1.8)

The minimum along $\overline{\epsilon}$ (for a true quadratic) is given by $(\overline{X}_m, f(\overline{X}_m))$ where

$$\overline{X}_{m} = \overline{X}_{0} + s_{m} \overline{\varepsilon}$$
 (1.12)

Since in general f is not quadratic, the quadratic search procedure is iterative and continues as follows. (Assume $s_i < s_k$.)

- 1. If $s_m > s_k$ or $s_m < s_i$, throw the worst point of Equation (1.10)—the point with highest payoff—and replace that point by $(\overline{X}_m, f(\overline{X}_m))$ for the next quadratic fit.
- 2. If $s_i \le s_m \le s_k$, we have two subcases to consider:
 - A. If the worst point is $(\overline{X}_k, f(\overline{X}_k))$
 - 1) If $s_m > s_j$, then throw away $(\overline{X}_i, f(\overline{X}_i))$ and replace it with $(\overline{X}_m, f(\overline{X}_m))$.
 - 2) If $s_{\underline{m}} < s_{\underline{j}}$, then throw away the worst point and replace it by $(\overline{X}_{\underline{m}}, f(\overline{X}_{\underline{m}}))$.
 - B. If the worst point is $(\overline{X}_i, f(\overline{X}_i))$
 - 1) If $s_m > s_j$, then throw away the worst point and replace it with $(\overline{X}_m, f(\overline{X}_m))$.
 - 2) If $s_m < s_j$, then throw away \overline{X}_k and replace it with $(\overline{X}_m, f(\overline{X}_m))$.

1.3 CONVERGENCE AND STOPPING CRITERIA

Convergence and stopping are controlled by the following conventions.

- 1. Maximum number of major iterations allowed is 20.
- 2. Maximum number of quadratic fits allowed in any one search is 7.
- 3. A quadratic search is called converged if
 - A. The current payoff value is less than or equal to the previously computed payoff value.
 - B. The difference between the previous payoff and the current payoff is less than 20 percent of the previous payoff (5 percent if there is only one independent parameter).
 - C. After A and B are satisfied, the algorithm tries twice more to get the current payoff less than the value obtained at the start of the current major iteration. If it fails, then only A and B are required for convergence. (Once convergence is achieved,

where

$$\overline{X}_{p} - \overline{X}_{o} + S(p, k_{\overline{\epsilon}}, q)$$
 (1.9)

Under these circumstances, the last three points, \overline{X}_p , \overline{X}_{p-1} , and \overline{X}_{p-2} , are fitted with a quadratic for a minimum. (This begins the quadratic search procedure for this case.)

If, however, the accelerated linear search is in an ascent direction—i.e., $\overline{X}_1 > \overline{X}_0$ —then the search continues for \overline{X}_2 in the direction— $\overline{\epsilon}$ by the magnitude of the step which produced \overline{X}_1 . If the triple \overline{X}_1 , \overline{X}_2 , \overline{X}_3 yields a concave upward set, then these points are fitted with a quadratic for a minimum.

If the triple \overline{X}_1 , \overline{X}_2 , \overline{X}_3 does not yield a concave upward set, then the descent portion of the algorithm is used, but now in the opposite direction. Once three satisfactory points are determined, the procedure goes into a quadratic search mode. This will now be considered.

Assume that somewhere along the line the accelerated linear search yields a concave upward set of three points—say,

$$(\overline{X}_{i} \ f(\overline{X}_{i})), \ (\overline{X}_{j}, \ f(\overline{X}_{j})), \ (\overline{X}_{k}, \ f(\overline{X}_{k}))$$
 (1.10)

with associated steps s_i , s_j , s_k , a quadratic fit is now made using the formula for the step to the minimum, s_m , given by

$$s_{m} = \frac{1}{2} \left\{ \frac{A_{1} + A_{2} + A_{3}}{B_{1} + B_{2} + B_{3}} \right\}$$
 (1.11)

where

$$A_{1} = \left(\overline{X}_{j}^{2} - \overline{X}_{k}^{2}\right) f(\overline{X}_{i})$$

$$B_{1} = \left(\overline{X}_{j}^{2} - \overline{X}_{k}^{2}\right) f(\overline{X}_{i})$$

$$A_{2} = \left(\overline{X}_{k}^{2} - \overline{X}_{i}^{2}\right) f(\overline{X}_{j})$$

$$B_{3} = \left(\overline{X}_{i}^{2} - \overline{X}_{j}^{2}\right) f(\overline{X}_{k})$$

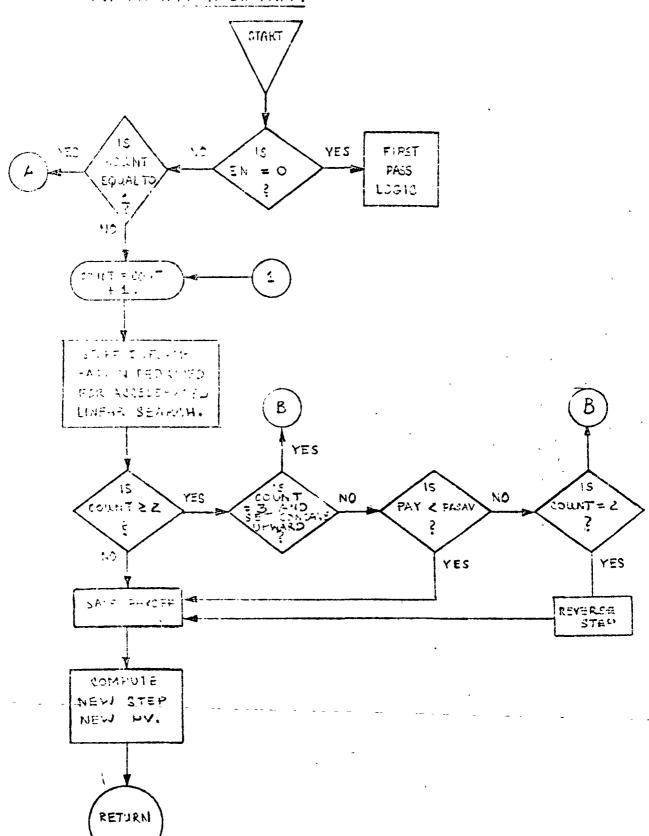
$$B_{3} = \left(\overline{X}_{i}^{2} - \overline{X}_{j}^{2}\right) f(\overline{X}_{k})$$

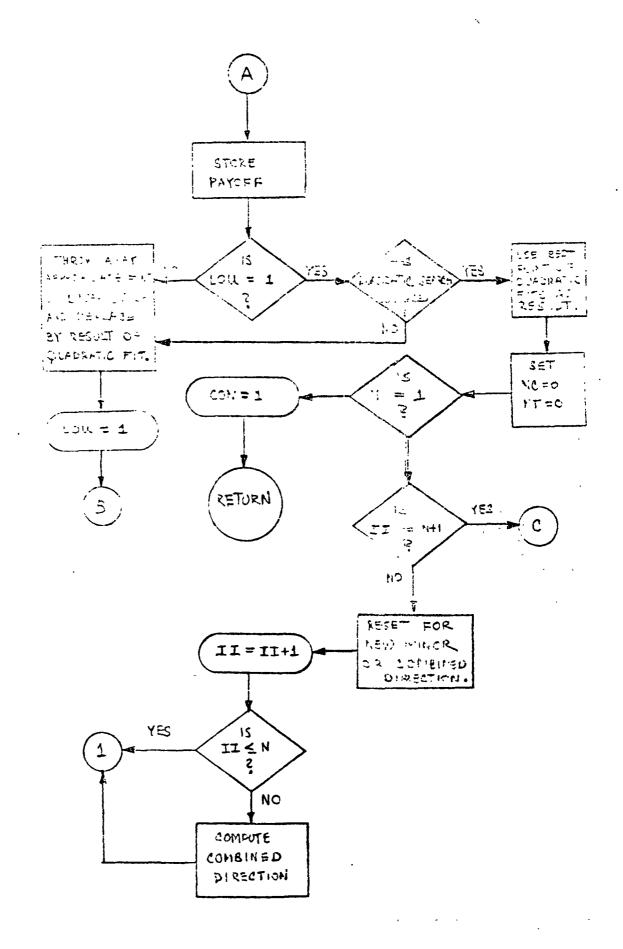
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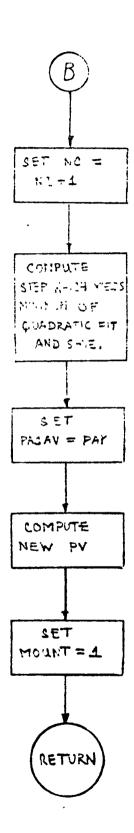
the best of the points generated is used to continue the algorithm.)

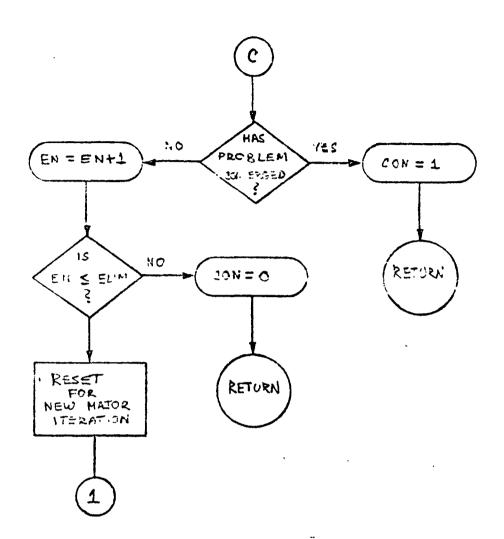
- 4. If N > 1, convergence of the total problem is achieved if the changes in the independent parameters are small (determined by an input tolerance).
- 5. If N = 1, convergence of the quadratic search is defined as convergence of the total problem.

LA DIOTRIC A DIAGRAM









```
3.0 LISTING
                  SURROUTINE -POWELL (PVTV) STEPTEPPTPAYT
                  COMMON /POWEL/
 000010
                 *DEL (11) . []
                                       . COJNT
                                                  ,XT(3)
                                                             .AT (3)
                                                                         .PVS(10)
                           7004
                 *P&S&<del>V---</del>
                                               <del>-1:01-</del>
                        POUNT
                                   ,GG(11,10)
                 *, PAO, NT. NC, DD, p(7), V(7)
                  COMMON/SIZIMG/DUMMY(-320)-ELIM
 000010
 000010
                  DIMENSION PV(1), STEP(1)
                 • , EPP(1)
                  INTROCK---COUNT-CONTEN-
 000010
 000010
                   INTEGER ELIM
                   IF(EN,GF,1) GO TO 19
 000010
                         FIRST PASS LOGIC
           Ç
            C
                  NC=0
 000012
                  NT=0
 000013
                  PAG # PAY
 000014
                  SC=1-
 000015
                  CON = -1
 000016
 000017
                  LOU=0
                  COUNT = 9
 0000000
                  POUNT #0
 000021
 000022
                  1131
 000023
 000024
                  DO 5
                         1=1.3
                  XT(I) = 0,
 000025
                5-AT(1) = 0.
 ~650000
 000031
                  DO 6
                         141.11
 000032
                6 DEL(1) = 0.
                  D0-10-1-1-N
----000035°
                  PVS(I) =PV(I)
 000036
               10 PPN(I) = PV(I)
 000040
 ~PPC909
                  NP1-=141
 000046
                  DO 17 1=1.NP1
                  DO 17 J =1,N
 000047
-0000050
                  1F(-1,EQ.J) GO TO 15
 000051
                  GG(1,J) = 0.
 000004
                  GO TO 17
 <del>000054</del>
               <del>15 66([|J)=-1.</del>
               17 CONTINUE
 000050
           Ç
            C
                         CHECK-VALUE OF MOUNT.
            Ç
                                   1.) IF MOUNT EQUAL ZERO STORE INFORMATION
            Ç
                                        REQUIRED FOR ACCELERATED LINEAR SEARCH.
                                   2-1-IF-MOUNT-EDUAL-UNE-CONTINUE-WITH-QUADRATIC-
                                        SEARCH.
               19-IF (MOUNT, EQ. 1) GO TO 100
 000065-
               20 COUNT = COUNT +1
 000057
 000071
                  XY(1) = XY(2)
 000072
                  <del>**(2)-=-**(3)-</del>
 000073
                  XT(3) = DEL(11)
 000075
                  AT(1) = AT(2)
  00076
                  <del>AT(2) = AT(3)</del>
 000077
                  AT(3) = PAY
 000100
                  IF(COUNT.GE.2) GO TO 70
```

```
SAVE PAYOFF TO CHECK IF ACCELERATED LINEAR SEARCH ------
                       SHOULD BE ENDED.
 00103
             52 PASAV = PAV
                       COMPUTE STEP SIZE FOR USE IN ACCELERATED LINEAR SEARCH,
          C
                       AND COMPUTE NEW VALUE OF PV.
                VAL = 0.
000104
                ₩0 53 1 01,N
700105-
             53 VAL = VAL + (GG(II,I)/STEP(I))++2
000107
                DEL(II) #1./SORT(VAL)
000123
000130-
                DEL(11) = 2.**COUNT*DEL(11)/(2.*EN)
000137
                DEL(II) = SC + DEL(II)
                DO 55 I #1.V
000142
             55-PV(1)= PPN(!) - DEL(11)+GO(11,1)
700146-
                RETURN
000156
                       CCMPARE-VALUES OF PAY A PASAV.
                                 1.) IF PAY IS LESS THAN PASAV, SET PASAV EQUAL
         C
                                     TO PAY, COMPUTE NEW STEP SIZE AND NEW VALUE
                                     OF-PV.
                                 2.) IF PAY IS GREATER THAN OR EQUAL TO PASAY.
                                             A. }
                                                  IF COUNT IS EQUAL TO TWO, SET
                                                  PASAV-EQUAL TO PAY - REVESS-T==
                                                  DIRECTION OF NEW STEP, COMPUTE
         C
                                                  NEW PW.
                                                  IF COUNT NOT EQUAL TO THE BEGING
         C
                                                  QUADRATIC SEARCH.
000167-
             <del>70 [F(PAY:OT:AF(1):AND:SS:EQ:=:5:AND:CCUNT:EQ:3) GO TO 75</del>
000203
                IF (PAY, LT, PASAV) GO TO 52
                IF(COUNT.EQ.2) GC TO 90
000205
         C
                       BEGIN QUADRATIC SEARCH.
         Ç
000207 ---
            -75-NGENG+1-
000211
                AA = (XT(2) \Rightarrow XT(3)) * AT(1)
                BB =(XT(3) = XT(1)) = AT(2)
000214
000217
                <del>CC-={XT(1} \ \ XT(2})\&AT(3}</del>
000222
                AS =(XT(2)++2 -XT(3)++2 )+AT(1)
000225
                BS =(XT(3)++2 -XT(1)++2 )+AT(2)
-000231-
                CS-={XT{1}++2--XT{2}++2-}+AT{3}
000234
                DD# (AS#BS&CS)/(AA+8B+CC)
000242
                DD = .5.DD
                DINC + DD
000243
                PASAV = PAY
000245
000246
                DO 85 1=1.N
000250-
             <del>85 PV(1)-= PPN(1) +DD+GG(11-1)</del>
000256
                MOUNT = 1
000257
                RETURN
         C
                       REVERSE DIRETION OF STEP.
            -90 SC-=-+;5
600270
000272
                GO TO 52
```

```
CHECK VALUE OF LOU.
                                       1 -1 - IF-LOU -EQUAL- TO ONE, CHECK-CONVERGENCE OF
               Ç
                                           QUADRATIC SEARCH
               Č
                                       2.) IF LOU EQUAL TO ZERO, THROW AWAY WORST
                                           VALUE OF ACCELERATED LINEAR SEARCH AND
               Ç
                                           REPLACE BY RESULT OF QUADRATIC SEARCH
     000272
                 100 V(NC)=PAY---
     000274
                      IF(LQU.EQ.1) GO TO 150
                  105 PMAX = AMAX1(AT(1), AT(2), AT(3))
     0002/6
     000304
                      £0 120 1=1.3
                      IF (PMAX, EG, AT(1)) GO TO 121
     000306
€.
                  120 CONTINUE
     000310
                 121 -JM -= 1----
    --- 000312--
     000314
                      PMIN = APINI(AT(1),AT(2),AT(3))
Œ.
     000321
                      po 130 !=1,3
                      if (PMIN.EG, AT(1)) GO TO 131
     <del>~000323</del>
                 130 CONTINUE
     000325
     000327
                 131 JS=1
     000331
                      JL = MOU(JM+JS,4)
                      15(JL, E3, 0) JL = 2
     000335
     000337
                      FM1 = AMAX1(XT(1), XT(2), XT(3))
     วบช3451
                      1 M2 = AM1N2(XT(1),XT(2),XT(3))
     000352
                      JF(DD.GT,FM1,OR,DD,LT,FM2) GO TO 141
                      IF(XT(JH).E0,FM1.AND.XT(JL).E0,FM2) G0 T0 137
     000353
     000374
                      <u>||F(XT(JH)=EC_FM2-AND-XT(JL)-EQ_FM1)-GO-TO-135</u>
                      GO TO 141
     000405
(
                 135 [F(DU,GT,XT(JS)) GO TO 141
     000405
                      <del>60 70 145</del>-
     000411
                 137 [F(DU.GT,XT(JS)) GO TO 145
     000411
                 141 XT(JM)=ED
     000415
                      000417
                      GO TO 149
     000421
     000421
                 145 XT(JL)=DD
                      YARE LILITA
     000423
     000425
                 149 LOU = 1
                      GO TO 75
     000426
                  150 IF (NC.GE.7) GO TO 152
     000427
     000452
                      IF (PAY, GT. PASAV) GO TO 105
                      TT = , 2
     000435
                      $F(N,E0,1) 77 =.05
     000436
                      IF (PASAV=PAY, GT. TT+PASAV) GO TO 105
     000441
     000446
                      IF(NT,EG,2) GO TO 152
     000450
                      NT-=NT+1-
                      IF(PAY,GT.PAO) GO TO 105
     000451
                             IF N EQUAL TO ONE, SET CON EQUAL TO ONE AND RETURN
€.
     000455
                 152 IM=1
  ----008456-
                      VM I N E V-(-1-)--
     000450
                      DO 153
                               1=2.NC
                      IF (VMIN.GT, V(I)) IM#I
     000451
     1000465
                  <del>153-VMIN-=V(-I++)-</del>
     000472
                      DD = D(IM)
                      DO 154 I=1,N
     000474
                 154-PV(1)-=PPN(1)+-DD +-G3(11,1)
     000475
     000513
                      PAY # V(IM)
     000515
                      NTEO
```

```
€
       000516
                        NC=0
       000517
                        -1 F-(N, EQ-1)--GO-+O-252-
       000521
                        IF(II,EG,N+1) GO TO 200
 £:
                 C
                 Ç
                               RESET FOR NEW MINOR OR COMBINED SEARCH.
9
       000523
                        DO 155
                                I=1,N
                    155-PPN(1) x PPN(1) + DD+3G(11,1)
       000524
                        SCF1.
       000535
 €
                        COUNT =0
       000536
       000537
                        MOUNT = 0
       000540
                        LOU # 0
 (
                        NP1=N+1
       000541
                        DO-160-1=1,NP1
       -000543-
       000544
                    160 DEL(1) = 0.
 •
       000547
                        11=11+1
       000551
                        15(11,45,N) GO TO 20
                 Ç
 E
                               COMPUTE COMBINED DIRETION.
                 C
       000553
                        GVAL=0
 (
                        D0 175 I = 1.N
       000524
       <del>000555</del>
                    175 GVAL = GVAL + (PPN(1) - PVS(1)) ++2
                        GVAL = SORT(GVAL)
       000553
 DO 180 I = 1.N
       000565
                    180 GG(!!, !) = (PPN(!) = PVS(!))/GVAL
       000571
                        GO TO 20
       000610
 C
                 Ç
                               CHECK CONVERGENCE OF PROBLEM:
       000611
                    200 DO 250 ! =1.N
                    250 - IF (ABS (PVS(1) - PV(1)), 37, EPP(1)) - GO - TO - 255 --
       000613-
                    252 CON = 1
       000624
                        RETURN
       000625
                 Ç
                               INCREMENT EN.
 6
                                        1.) IF EN IS LESS THAM OR EQUAL TO ELIM RESET
                                              -ROR-NEW-MAJOR-
                                         2.) IF NOTISET CON EQUAL TO ZERO AND RETURN.
 C
                 Ç
                    255 EN=EN+1
       <del>000626</del>
                        IF(EN.LE, ELIM ) GO TO 260
       000630
                        CON = 0
       000632
                        RETURN
       000633
                    260 DO 261 1 = 1,N
       000634
 •
                        PVS(I) =PV(I)
       000636
                    261 PPN(1) = PV(1)
       <del>000640</del>
       000644
                        PAO = PAY
 (
       000645
                        11 =1
       000646
                        SC-=-1,
                        COUNT=0
       000647
       000650
                        MOUNT = 0
       000651
                        LOU-
                              -------
                        NP1=N+1
       000652
                        DO 265
       000624
                                 I=1,NP1
                    265 DEL(1) = 0.
       000655
                        DO 270
       000660
                               1 = 1.N
       000662
                        DO 270
                                 J =1.N
 Ę
```

| (| 000653 27 | 0 GG([,J) GG([+1,J) | | | |
|----------|---|---------------------|--|---|-------------|
| C | 000677 | END | | , | |
| 6/1 | | | | | |
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Section 4 GLOSSARY OF TERMS

| Name | <u>Definition</u> |
|-------|---|
| AA | Working variable used to compute minimum of quadratic fit. |
| AS | Working variable used to compute minimum of quadratic fit. |
| AT | Array of Dimension 3 which stores the payoff valves of the accelerated linear search used in the quadratic search. |
| ВВ | Working variable used to compute minimum of quadratic fit. |
| BS | Working variable used to compute minimum of quadratic fit. |
| CC | Working variable used to compute minimum of quadratic fit. |
| CON | Flag which indicates convergence of problem. |
| | If CON = 1, problem has converged If CON = 0, iteration limit exceeded without convergence. |
| COUNT | Number of steps taken in accelerated linear search (including the null step). |
| CS | Working variable used to compute minimum of quadratic fit. |
| D | Array of Dimension 7 which stores the step sizes to a minimum for any single quadratic search. |
| DD | Step size to a minimum obtained from quadratic search. |
| DEL | Step used in accelerated linear search. |
| ELIM | Maximum number of major iterations allowed. |
| EN | Major iteration counter. |
| EPP | Convergence tolerance: for $N > l$. If the difference between the independent parameters in two successive major iterations are all less than EPP, then the problem has converged. |
| FM1 | Maximum of the three steps used in any one pass of the quadratic search. |

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| Name | Definition |
|-----------------|--|
| F _{M2} | Minimum of the three steps used in any one pass of the quadratic search. |
| GG | Array of dimension (10 x 12) which contains the direction vectors. |
| GVAL | Magnitude of combined direction vector. |
| II | Counts the number of search directions per major interaction. |
| JL | Index of the step sizes for the maximum payoff of the three payoff values used in any single pass of the quadratic search. |
| JM | Index of the step size for the middle valued payoff of the three payoff values used in any single pass of the quadratic search. |
| JS | Index of the step size for the smallest payoff of the three payoff values used in any single pass of the quadratic search. |
| MOUNT | Flag so that, |
| | If MOUNT equals zero, store information required for accelerated linear search. If MOUNT equals 1, continue with the quadratic search. |
| N | Number of independent parameters. |
| NC | Counts number of passes in any single quadratic search (Max = 7). |
| NT | Counter which limits to two the number of attempts to get payoff less than the value achieved at the start of the current major iteration (after certain weaker convergence criteria have been met). |
| PAO | Payoff value at start of a major iteration. |
| PASAV | Previous payoff value. |
| PAY | Current payoff value. |
| PMAX | Maximum payoff of the three payoffs used in any single pass of the quadratic search. |
| PMIN | Minimum payoff of the three payoffs used in any single pass of the quadratic search. |
| PPN | Vector which defines current search direction. |
| PV | Independent parameter array (Max = 10). |

| ίτ <i>)</i>
Γι. | Name | Definition |
|--------------------|------|--|
| i_{i} | PVS | Independent parameter array for previous major iteration. |
| | SC | Multiplier which reverses direction of linear search. |
| | STEP | Nominal step size array (Max = 10). |
| | XT | Array of Dimension 3 which stores the steps of the accelerated linear search to be used in the quadratic search. |
| | v | Array of Dimension 7 which stores the payoff values for any single quadratic search. |

Working variable used to compute $k_{\overline{\epsilon}}$. VAL

Working variable used to compute index of best point in any single quadratic search. VMIN

Appendix A ON THE CHOOSING OF A STEP SIZE

The method for determining the step size $S(p, k_{\overline{\epsilon}}, q)$ will now be presented.

The nominal steps s; associated with each independent parameter determine an ellipse in X-space; viz,

$$\sum_{i=1}^{N} \left(\frac{x_i}{s_i} \right)^2 = 1 \tag{A-1}$$

Given a direction determined by a unit vector,

$$\overline{\varepsilon} = (u_1, u_2, \ldots, u_N)$$

we wish to find a constant k_{ϵ} so that, k_{ϵ} lies on the ellipse in Equation (A-1).

Therefore the following equation must be satisfied;

$$\sum_{i=1}^{N} \left(\frac{k_{\varepsilon} u_{i}}{s_{i}} \right)^{2} = 1$$
 (A-2)

Solving for k_{ϵ} we obtain,

$$k_{\varepsilon} = \left[\sum_{i=1}^{N} \left(\frac{u_{i}}{s_{i}}\right)^{2}\right]^{-1/2} \tag{A-3}$$

Therefore, the step taken in the direction $\overline{\epsilon}$ should have magnitude $k_{\overline{\epsilon}}$.

To accelerate the linear search, k_{ϵ} is multiplied by the factor 2^{p-1} , but, also, to cut down the size of the step as convergence is approached, 2^{p-1} k_{ϵ} is divided by q (p = number of previous steps; q = major iteration number). Therefore, we have

$$S(p, k_{\overline{\epsilon}}, q) = 2^{p-1} k_{\overline{\epsilon}}/q \qquad (A-4)$$



Appendix B NUMERICAL RESULTS

The subroutine was tested on Rosenbrocks function of two variables x₁, x₂; viz,

$$f(x_1, x_2) = 100 (x_2 - x_1^2)^2 + (1 - x_1)^2$$
 (B-1)

with the starting conditions

$$x_1 = -1.2$$
, $x_2 = 1$ (B-2)

Two major cases were considered, each with its own spectrum of step sizes (the s_i). All cases converged but with a varying number of function evaluations. (In all cases $s_1 = s_2$.)

The converged values to the problem are

$$x_1 = x_2 = 1$$
, $f(x_1 x_2) = 0$. (B-3)

The number of function evaluations to get f $(X_1, X_2) < 10^{-5}$ and f $(X_1, X_2) < 10^{-9}$ is tabulated in the following charts.

Case 1: NO CONSTRAINTS ON INPUTS

| Step
(s ₁ = s ₂) | No. of evaluations for $f < 10^{-5}$ | No. of evaluations for $f < 10^{-9}$ |
|--|--------------------------------------|--------------------------------------|
| .1 | 226 | 237- |
| 4 | 189 | 197 |
| .5 | 167 | 181 |
| .6 | 188 | 197 |

Case 2: INPUT CONSTRAINTS

The constraints are,

$$-5 \le x_i \le 5$$
 , $i = 1, 2$

| Step
(s ₁ = s ₂) | No. of evaluations for $f < 10^{-5}$ | No. of evaluations for $f < 10^{-9}$ |
|--|--------------------------------------|--------------------------------------|
| .05 | 167 | 177 |
| . 1 | 127 | 155 |
| . 2 | 269 | 285 |
| . 4 | 253 | 270 |

Ground Rules for Modifying PADS

REFERENCES

- 1. M. J. Box. A Comparison of Several Current Optimization Methods, and the Use of Transformations in Constrained Problems. Computer Journal, Vol. 8, No. 1, 1965, pp. 303-307.
- 2. M. J. D. Powell. An Efficient Method for Finding the Minimum of a Function of Several Variables without Calculating Derivatives. Computer Journal, Vol. 7, No. 4, 1964, pp. 303-307.



GROUND RULES FOR MODIFYING PADS

In this section of the program description, some suggested procedures for modifying the applied load models, control governing equations and boundary conditions in PADS are presented. Referencing of the formulation document Volume I, is used throughout the discussion and both FORTRAN and engineering notations are used depending on which better describes the situation. Implications for input are discussed in the last sub-section.

Since the trajectory module of PADS contains both the steepest descent and quasilinearization modules, there will be some special differences in programming changes. For the most part, those differences are related to the following:

- a. Q-L Optimal Control calculation ALGCON ALl subroutines
- b. Common block communication
- c. Arc initialization
- d. Need for first and second partial derivatives in QL module and only first partials in SD module.
- 1. Applied load model change.

The addition or modification of an applied load model requires that the formulation and coding of the accleration vector, a, and its partials with respect to state, y and the in-plane control vector, u, be redone. The coding for this type of change is outlined in chart 1.

2. Control governing equations.

A simpler modification to the program is the addition or modification of a governing equation as given for example in Section 9 of Volume I.

Chart 1

Applied Load Model Modification

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| Comments | | | | ARCDAT common block "BOOT" B. |
|------------------|--|---|--|--|
| 링 | APPLY | STATEF | UTNOP
UT
AEROCØ
MØMECØ
MØMECØ | AKCIN
DYNA
ARCDAT |
| Steepest Descent | ACCEL | EQUA 3 | VTNOP VT BEROCØ MANECØ IMPULS | PRØP IN
PRØPB
FNTG
GENF
AECØ3
ARCDAT |
| Description | Acceleration vector and its partial derivatives (1st, 2nd and mixed) with respect to state y and in-plane control u. | State only dependent terms in acceleration vector (e.g. aero-coefficients that are dependent on MACH number) and their partial derivatives. | Control vector dependent terms in the acceleration vector and their partial derivatives. | AKC INICIALIZACION LOGIC Common blocks that may need changes |



If an applied load model is added or modified, it is often necessary to change one or more of the governing equation's subroutines.

The general form of the governing equation is

$$K_4 = K_4 (y,u) = 0$$

In the program the preferred form of K, is

$$K_i = K_i [y,a (u,y)]$$

where a is the acceleration vector.

Each of the options for K_1 is programmed in a separate subroutine along with its partial derivatives, first with respect to the control vector and then with respect to state. The reason for including the acceleration vector in the K_1 dependency is that this vector and its partials are already computed at the time K_1 and its partials are needed. This convenience permits a simpler representation of K_1 and its partial derivatives through the use of chain rules. For example, the explicit partial of K_1 with respect to α is

$$\frac{\partial K_{i}}{\partial \alpha} = \frac{\partial K_{i}}{\partial a} \frac{\partial a}{\partial \alpha}$$

Boundary Conditions

The function or non-linear target equations and their explicit partials with respect to state are all contained within subroutine PDBC in the steepest descent module and its parallel counterpart, PDBCQL, in the QL module.

In order to add or modify a boundary condition, it is only necessary to supply the equation for the function in terms of common supplied state and state functions and derive and code the partial derivatives of the function with respect to the state vector.



Input Implications

The impact of program modifications on the data input interface can be very significant.

4-a. Applied load model input implications.

For applied load model changes, the following must be considered. Arc dependent input data is stored as an array on random file. This array contains 51 words including such things as aerodynamic reference area, curve numbers, rated vacuum thrust etc. (See ARCDAT common.) The representation of this data in the input routine, INEDIT, (see this volume), is a set of 51 subscripted arrays; each array having 20 words to correspond with the maximum number of arcs in the trajectory. If it necessary to expand the number of words in this array, first the address equivalencing in the /AA/ common block in subroutine INEDIT must be shifted. Then the new variable names added to common /AA/ and to the NAMELIST/XX/ statement set. Common block /ARCDAT/ should be expanded to include the new variable names and arc initialization coding (see chart should reflect the larger size of COMMON/ARCDAT/. If fixed point flags are added and print out of the new data is desired, subroutine FXDAT should be amended. Also the construction of the random file 9 should be changed to reflect the larger size of COMMON/ARCDAT/.

If desired, the meaning of words in /ARCDAT/ can be shared between different models in order to save the trouble of expanding the size of the common block. This could be handled by simple equivalencing in the subroutines that are affected. These routines should include INEDIT, where equivalencing

and dimensioning new variables in COMMON /AA/ could be accompanied by the addition of the new variable namesinto the NAMELIST/XX/ set.

B. Governing equation input implications.

Governing equation options are regulated by choice of option flags contained usually in COMMON/ARCDAT/. Therefore, the interfacing coding changes will only appear in the arc initialization and control choice logic. The arc initialization is described in Chart 1. The control choice logic is found in the steepest-descent module in subroutines MODELA, and BLGCON and in NPLANE and ALGCON in the QL module.

C. Boundary condition input implication.

The addition of a new boundary condition has important significance to the boundary condition checking and set up in Program (CDC) or Subroutine (UNIVAC) SDINP and its subsidiary routines. The logic for printout of the name of the target should be added to SDINP. Functions LOMG, MOMG, MPSI, TOL, SOMG, SPSI, TOLPSI, need modifications to reflect the addition of a target with a variable number code greater than 36, (see Table 2.6-1 in Volume III), requiring a preset tolerance value, and possible having different input units than internal units.